A TREATISE

ON

SUGAR MACHINERY:

INCLUDING

THE PROCESS

OF

PRODUCING SUGAR FROM THE CANE, REFINING MOIST AND LOAF SUGAR,

HOME AND COLONIAL;

THE

PRACTICAL MODE OF DESIGNING, MANUFACTURING, AND ERECTING THE MACHINERY;

TOGETHER WITH

RULES FOR THE PROPORTIONS AND ESTIMATES.

ILLUSTRATED BY FOUR SINGLE AND TWELVE LARGE FOLDING PLATES.

BY N. P. BURGH,

ENGINEER.

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PREFACE.

THIS work is intended for the use of Sugar Planters, Refiners, Engineers, &c., showing the present process of producing sugar from the cane, and of manufacturing and arranging the machinery. The designs and rules are given from practice, but at the same time, may be susceptible of improvement.

ANALYSIS.

PROCESS.

The author has endeavoured to show clearly the necessary amount of information on this subject, to enable correct calculations to be made, so as to determine the machinery, &c., requisite in proportion to the produce required. For the information acquired and rendered in the Colonial Process, the author begs to express his deep obligation to P. L. SIMMONDS, Esq., F.S.S., author of the ***Dictionary of Trade Products***, &c., &c., &c. The information on the Home Process has been obtained from the author's professional practice, but not being a sugar boiler or refiner, he trusts that any defects or omissions will be leniently received.

MANUFACTURING MACHINERY.

In this part of the work the author has endeavoured to show the mode of producing effective and durable machinery of the best kind he is at present conversant with.

ERECTING AND CONNECTING.

As this branch of engineering is an important one, the author has deemed it requisite to describe in detail, the proper method of erecting and constructing the whole of the machinery used in the produce of sugar from the cane; but more particularly that of the sugar mill and vacuum pan, these two apparatus being the most essential.

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of an inch apart. The speed of the periphery of each roll is from 18 to 20 feet per minute; this speed will insure time for the cane to be perfectly crushed, also the liquor to drain from the megas as it passes over the guide; the canes should be put singly on the feed table, and allowed to slide gently, in order that the rolls may nip them with a gradual propelling power; it is not practically essential that the megas should be thrice pressed or squeezed, as the increase of labour expended to extract any remaining juice, is more than equivalent to the value of the quantity gained thereby; the megas comes from the mill in lengths of about 3 to 4 feet, of a flat uneven surface, it is then allowed to drain, and afterwards dried in the sun, or in a steam drying-house prepared for that purpose, after which it is used for fuel, being of an exceedingly gaseous nature, therefore a good producer of heat. The cane-juice should never be allowed to remain in its then present state more than 5 or 6 hours, as at that time the acidification and fermentation commencing, tend to destroy the saccharine portion, which is the principal part sought after ; presuming a sufficient quantity of cane to be crushed, the next part of the process in rotation will be the evaporation of the water in the cane-juice, and cleansing by clarification.

CLARIFYING, DEFECATING, AND CURING.

The liquor or cane-juice being in the clarifiers to a height from the top of about 6 to 8 inches, steam should be admitted in the worm at a pressure of not more than 12lbs. to 14lbs. per square inch. On the liquor being heated to a temperature of about 130° to 140°, lime, or milk of lime, is added in the proportion of from 2 to 3 ounces per 100 gallons of liquor to be clarified; the whole is gently stirred; as soon as ebullition ensues, or the temperature reaches from 190° to 205°, or being near boiling point, the steam is shut off, and the liquor remains dormant from about 10 to 15 minutes; the portion under the strainer is then drawn off, and used with the next quantity to be clarified; the clarified liquor is then allowed to run into the bag filters, directly underneath, care being taken to stop the liquor before the dark thick scum mixes with the reduced quantity; the clarified liquor having passed through the bag filter, it is received into a tank with a worm in it, to preserve the temperature, which should not be below 100°; it is then by the vacuum pan defecated, and still further evaporated to a syrup of a purer nature, the sufficiency of which is indicated by the agitation of the boiling, at the same time, by the sharpness of the edges of the different forms the syrup assumes. On taking proof by the proof rod, the syrup is taken between the forefinger and thumb, and, on gradually separating the same, is seen to be more or less tenacious, at the same time slightly crystallized; to make raw or unrefined sugar, it is from the vacuum pan received into a copper cooler directly underneath, from thence put in quantities of about 2 cwt. into the centrifugal machine, the baskets of which are driven at a velocity of from 800 to 1000 revolutions per minute, so as to cure or force the liquid from the saccharine matter; the sugar is then put into casks, and exported to the different markets, England being the principal. For the benefit of the planters, it will be requisite to describe the process of refining sugar, or converting the raw sugar into crystallization, moist brown sugar being cured or dried for shipment purposes, for the convenience of carriage, and less in weight, &c., consequently, where no raw sugar is exported, no curing previous to completing the entire process of crystallization is entirely requisite.

REFINING COLONIAL.

As the arrangement of the machinery used in refining sugar in the colonies differs from that of those at home, it will be well to engross the attention to each department separately, commencing with that for the colonies.

FILTERING AND DEFECATING.

Presuming the cane-juice to be clarified, filtered, and defecated, and intended to be refined, it should from the vacuum pan run into the heaters, from thence to the defecating pans; when it is heated to a temperature of about 160° to 180°, add from 3 to 4 ounces of milk of lime, and continue the heat to the same temperature for about 30 to 40 minutes, producing a thick scum on the top, which breaks and shows (underneath it) a white froth. When the froth curls back or exposes the liquor, the steam should be shut off, and the liquor allowed to settle for about 15 to 20 minutes, the foul liquor should be drawn off, reserved for the next defecation, the clear liquor running through the bag filters at the rate of 1000 to 1300 gallons per hour, into the divisional sight tanks, from them into the receiving tank below the bag filters; these tanks have a coil of steam pipes at the bottom so as to preserve the temperature of the liquor (but this arrangement is not essential if the room be heated by steam pipes); from the tanks the liquor is elevated into the divisional sight tanks flowing from them into the charcoal filters at the rate of from 400 to 600 gallons per hour, but as the number and size of the charcoal filters exceed that of the bag filters, the process of filtering will be continued without intermission as far as practical contingencies will admit; the liquors on passing through the charcoal filters should run into divisional sight tanks, and direct from them into a receiving tank in the same room.

BOILING.

The boiling in vacuum again takes place to complete the crystallization of the sugar, the liquor in the receiving tank (by the vacuum caused in the pan) is forced into the measure, and from it let into the pan; 8 to 10 measures should be let into the pan, steam having been partially turned into the worm at the commencement of the third measure, the quantity of 8 to 10 measures should be allowed to boil in vacuum for about a quarter of an hour, after which, let in the remaining quantity to fill the pan from 4 to 6 inches above the worm. The temperature should never exceed 180°. The time required for boiling is various; $2\frac{1}{2}$ to 3 hours for about 7 tons of sugar is the average, but this depends chiefly on its nature.

HEATING.

When the sugar is sufficiently boiled, it is (from the vacuum by the discharge valve) let into the heaters, and there heated to a temperature from 175° to 180°; during the heating process the sugar should be constantly agitated by manual or steam-power. Long mashing oars are often used by one man to each heater to accomplish the mixture of the grain.

FILLING AND DRAINING.

Having obtained the proper temperature in the heater, the sugar should next be allowed to flow into moulds arranged in rows; the congelation in these moulds is complete in about 10 or 12 hours; each is then emptied, and the loaves pierced with a steel or iron rod at the small end, from 8 to 10 inches deep, the upper part of the top is cut off and the loaf put into moulds so as to drain effectually.

MAGNEY.

Refined sugar mixed with pure water in a tank so as to effectually melt the same is then called "magney," or fine liquor; its use is to thoroughly cleanse the loaves from the colored syrup, also to produce the white appearance so well known in loaf sugar. The loaves are now allowed to drain to a certain dryness in proportion to their size and weight. The next process is to take each loaf from its mould by slightly knocking it with a mallet, or on the floor; the loaf is then trimmed perfectly flat at each end with a trimming knife, or machine, the small loaves are nosed, or coned at the small end by the same means. Care should be taken in trimming each loaf that no colored part be allowed to remain.

DRYING.

Presuming the loaf to be properly trimmed, it is neatly wrapped in blue or white paper and put into the drying store—viz. within a close compartment; a series of pipes are fixed horizontally at the bottom, above this, about 18 inches to 2 feet, is a platform of wood, stone, or iron, either of which should be as a grating or rack, in order to allow the heated caloric to ascend. These racks should be from 2 feet 6 inches to 3 feet 3 inches in height, according to their width; narrow racks require less space between them in proportion to that of the wider kind. Temperature of the stove should be from 130° to 140°. The loaves are laid on the racks transversely side by side. Care should be observed that in packing them the small end should be alternately on the same line with each other; the loaves can be packed from 4 to 6 tiers high, but so that the heated air can pass freely amongst them. The time required to effectually dry these loaves is from three to five days, but the variation depends on the heat of the stores, moistness of the loaves, and nature of the sugar, when first put in. When dry, they are put into racks, or cases in the warehouses, from thence to the market.

This will prove that 27.9 to 30 cubic inches of loaf sugar equals 1 lb. in weight. It must be understood, on commencing, it is better to devote the first four days to making the best sugar in loaves and tittlers, the next day to making lumps, on the sixth day the whole of the impurities of those made (during the above-stated period) should be re-melted, together with the coarsest liquor, to produce bastards; this last is very rarely sent to market, undergoing the entire process again to produce refined sugar.

REFINING FOR CURED SUGAR.

The process of refining sugar to be cured, will be exactly as that of the loaf sugar, with the exception that the liquor is never heated to a temperature above 127° to 130° in the vacuum pan. After boiling from $3\frac{1}{2}$ to 4 hours, proof should be taken, which, if satisfactory, will represent a pale, clean, gummy substance, having crystals more or less in it, according to the nature of the sugar or cane-juice.

CURING.

When the sugar in the vacuum pan is sufficiently boiled, the steam going into the worm should be entirely shut off, at the same time the sugar let into copper coolers below the vacuum pan; these coolers are merely vessels similar to the heaters in shape, but no steam being applied, having a discharge sluice valve to let the sugar flow into trucks on wheels, capable of containing from 2 to 3 cwts.; the sugar is from these trucks put into the centrifugal machine, before mentioned in Chapter I., and the basket caused to revolve at a speed of about from 500 to 600 revolutions per minute, which occupies about 4 to 6 minutes; it is then taken from the machine to the warehouse, and packed in hogsheads.

REFINING AND CURING (HOME).

The sugar used by refineries in England is usually imported in hogsheads, the timber weighing from $1\frac{1}{2}$ to $1\frac{3}{4}$ cwts., and the sugar weighing from $15\frac{1}{2}$ to $16\frac{1}{2}$ cwts., making a total of about 17 to 18 cwts. for West India sugar, and from 12 to 14 cwts. for that of Portuguese. In a sugar-house for refining raw or brown sugar as imported from Cuba, and other places, the process will be thus:—The sugar is put into bins, or square wooden or iron receptacles, afterwards into the blow-up pans, which are round with flat bottoms; these pans are usually of cast iron, with revolving geering overhead, to drive a perpendicular rod or shaft having 2 arms 6 inches from the false bottom, and 2 arms half-way from it and the top. These arms agitate the sugar after it is melted partially, so as to thoroughly mix the same, the speed being from 12 to 20 revolutions per minute. The false bottom is composed of a cast-iron plate, perforated with small holes; underneath the same is a worm or series of copper steam pipes from 4 to 6 inches in diameter, having $2\frac{1}{2}$ inches inlet, and 1 inch outlet, to condense water box; the time usually taken to blow up 4 tons of sugar is half an hour, the syrup flows from thence into the bag filters, composed of linen bags from about 3 to 4 inches in diameter; these bags are suspended by, or from, a bell-shaped tube $1\frac{3}{4}$ inches in diameter at the top, and from 2 to $2\frac{1}{2}$ inches at the bottom, length 6 inches; each of these bell-shaped tubes screw into a metal plate,

the bags are tied by strong cord on to each bell tube, the whole inside a cast-iron casing, which has also a false bottom to receive any impurities which might fall thereon from the bursting of any of the bags and stockings, or casings which surround them; these bag filter casings have a door, steam tight, so as to cleanse the inside of the filters, supply or remove dirty or clean bags, as the case requires, in order to keep the syrup in a liquid state; steam at a medium rate (in some cases) is let into the casing so as to keep up the requisite temperature; as the syrup flows from or through the several bags, it passes into small cisterns of about 8 inches deep, 8 inches wide, and from 2 to 3 feet long, in order to see the purity or impurity of the syrup; these cisterns have holes, attached to which are pipes to convey the syrup to the charcoal cisterns, each 5 feet 6 inches at the bottom, and 6 feet at the top, and from 16 to 20 feet deep; these cisterns are of wrought iron, from 12 to 18 inches from the bottom, are false bottoms perforated, on the top of which is laid a piece of the best flannel, and animal charcoal in a prepared state is laid on the same, so as to fill the cistern from 2 to 3 feet from the top; the syrup flows from the bag filters into these charcoal filters, and proceeds to the bottom, leaving more or less of its impurities, in, and amongst the animal charcoal; when the syrup for the day's boiling is entirely out of the bag filters, water is allowed to flow in on the top of the animal charcoal, so as to effectually drive all the syrup out of the same; on leaving the charcoal filters the syrup flows into a small series of cisterns, already described, in order to be tested and examined as to its color, purity, &c., continuing to flow into a cast-iron cistern, about 4 feet 6 inches deep, 8 feet long, and 5 feet wide, or of any other convenient dimensions; the syrup is then forced by the vacuum caused by the pumps into the vacuum pan, and is boiled from about 3 to 4 hours, care being taken not to boil it more than from 120° to 127°; the sugar (it may now be designated) is let into large copper vessels, called coolers, of the same shape as the lower part of the vacuum pan, and from them into the centrifugal machines; after putting a proper quantity into the same, from the bottom to a depth of about 4 inches, a revolving motion is given to the sugar by a small steam engine, for from 4 to 5 minutes, at a speed of from 500 to 600 revolutions per minute, the liquid sugar by the centrifugal motion is cured, or formed into a crust, equal in thickness around the inner side of the basket of the machine, the syrup flowing therefrom into a tank below; by this process raw sugar can be refined into *white* crystallized moist sugar in about four days.

"REFINING" PRODUCING LOAF SUGAR (HOME).

The arrangement for refining sugar to be drained and dried, so as to produce loaves, tittlers, lumps, and bastards, is as follows:—The house is from seven to eight stories high, generally in two compartments, one for melting and boiling, and the other for draining and drying. To recapitulate the process of blowing up, filtering, and boiling, is not here essential, the reader having been already made acquainted with it in detail in the last chapter; the temperature of the sugar whilst in a liquid state should be from 10 to 15 per cent. more than for the moist process.

DRAINING.

The time varies for draining: bastards taking 3 weeks in some cases, lumps and tittlers

from 4 to 6 days, loaves 3 to 5 days; this must not be deemed imperative, as the purity of the sugar is the chief guide; the moulds are lifted by the pulling-up machine from floor to floor as required, each loaf is shaped and nosed (bastards, lumps, and tittlers being flat at the ends), the tittlers and loaves are wrapped in paper and dried in the stove for a period of from 3 to 4 days, at a temperature varying from 130° to 140°. Refiners in London generally make refined sugar the first 4 days, the remaining time is devoted to lumps and bastards, the lastly mentioned being the refuse of the 5 days' work, together with the coarsest sugar. The lumps and bastards are, by the shaving machine, cut into small particles, and the top and bottom of the tittlers and loaves crushed in a mill, having 2 shafts with from 8 to 10 short knives in each; underneath are two rolls from 12 to 14 inches diameter, and from 2 to 2 feet 6 inches in length, tooth wheels being introduced at one end on each shaft, so as to effectually cause a rotary motion, which is obtained in most cases from steam power; by this means, the shaved and crushed sugar can either be re-melted or packed in casks, as moist sugar. The entire process of colonial and home production of moist and loaf sugar having been, it is hoped, clearly elucidated, the next course is to explain the animal charcoal used as a purifier; this substance is produced from the bones of animals burnt to a highly charred state in sealed receptacles, and ground to substances about $\frac{1}{8}$ of an inch in diameter, or square, as the case is. Cisterns are provided of various sizes; from 18 to 20 feet in height, and from 6 to 6 feet 6 inches in diameter, are used in England, but less in height in the colonies; charcoal in its pure state occupies a space of from 30 to 35 cubic feet per ton; after being used as a purifier it is washed and revivified, by which means it occupies 10 per cent. more space than when new. The following will be about the quantity required in proportion to the sugar used in a London sugar-house:—

Example 1.

Producing	in 6 days	216	tons of	sugar,
Requiring	"	117	"	charcoal.

Example 2.

Producing	in 6 days	205	tons of	sugar,
Requiring	"	169	"	charcoal.

No molasses was made.

In Example 1 the proportion is: charcoal being 1, sugar 1.854.

In Example 2 the proportion is: charcoal being 1, sugar 1.213.

By this it will be seen that 1 ton of charcoal will purify from 1 to 2 tons of sugar, the proportion varying in proportion to that of the qualities of the sugar and charcoal. The latter is never used longer than from 4 to 6 days, after which it is washed and revivicated in revolving retorts, care being taken not to admit cold air during the operation. The time required per ton for the process is not imperative, as it entirely depends on the nature and original state of the charcoal. A set of revolving retorts is shown in Plate 14, designed by the author.

The following statistics are given of the average produce of the sugar-cane:—

[illegible] of cane produces 60 to 80 per cent. juice; 1800 gallons of cane-juice produces

1 hogshead of raw sugar, weighing from 16 to 18 cwts.; 100 lbs. of cane-juice produces from 15 to 20 lbs. of raw sugar.

In the case of refining, the loss contingent on raw sugar is from 4 to 10 per cent.; the former being the lowest proportion that has come under the author's notice.

CHAPTER III.

MANUFACTURING.

SUGAR-CANE MILL. (PLATE 1.)
CAST-IRON DETAILS. (PLATE 2.)

As this apparatus is the first mover of the whole process of making sugar from the cane, it will be well for the reader to become acquainted with the mode of manufacturing the different details, which will enable him to understand their purposes hereafter described. The cast-iron details predominating in quantity, should first engage the attention of the maker. Great care must be taken in designing, that all parts of the mill subject to an equal strain, are equal in section; this should be more particularly attended to in the side frames and bed plate, these being subject to the entire weight of the remaining parts of the mill. In the construction of the patterns for the sugar-mill, care should be taken to allow at least $\frac{1}{4}$ of an inch for planing and fitting, as the casting in many cases being large, may by accident be slightly defective in the particular part or parts required to be surfaced; all bolt holes below $1\frac{1}{2}$ inches should be drilled after casting, and all holes cast, should be cored larger in the middle, at least $\frac{1}{8}$th of the diameter of the bolt. The different details, and their mode of manufacture, will now engage attention, and be described.

Side Frames.

These frames should be sound good castings, free from air holes or defects of any kind. To insure toughness of the iron, the casting should be allowed to cool gradually and equally; all uneven parts are to be chipped off, and all parts to be surfaced, planed, chipped, and filed, as the case requires, care being taken to work from centre lines in all cases, to insure accuracy in dimensions and surfaces at right angles with their respective centre lines; all bolt holes should be bored, drilled, or chipped, as the case requires, to the exact size of their respective bolts, to insure compactness in construction, preventing any undue strain, thereby insuring durability.

Rolls.

These being of a simple nature, need very little description; they should be cast in loam, perpendicularly, 12 or 15 inches longer than required, so as to insure a close fibre of metal, allowed to cool equally, but not too slowly, as the harder the roll the better, but care must be

taken to attend to the cooling, to be able to smooth turn or surface the periphery, which is done after the rolls are keyed on their respective shafts.

Side Frame Caps.

These should be cast clean, surfaced where requisite in the shaping machine, and the bolt holes bored.

Distance Pieces.

These should be cast clean and surfaced at the ends, and the bolt holes chipped and filed to the required size at each end.

Bed Plate.

This should be cast clean in loam, and gradually cooled, planed, and surfaced to receive the side frames, and the bolt holes bored.

Feed and Discharge Tables.

The brackets should be carefully cast, to insure the proper angle and fitting in the provision in the side frames, cast thereon to receive them; all holes should be drilled, and the plate holes counter sunk, as shown.

Cane Guide.

This should be cast in loam, and cooled gradually to insure toughness; the holes must be drilled and filed, and the nut bosses surfaced.

Cane Juice Tank, Strainer, and Bottom.

These are cast separately, all joints surfaced, and holes drilled, the flange of the suction pipe and fitting strip for the pump to be planed and surfaced.

Spur Pinions.

The pattern of these should be well and separately made, and dovetailed together when complete, the thickness of the teeth at least $\frac{3}{32}$ of an inch more than required in practical working contact with each other, to allow for pitching and trimming (which, after keying the pinion on the shaft, is accurately done), to the radii produced by the Odontograph, invented by Professor Willis; this mode will insure a pleasant working motion, although the pitch circles may be out or not, in rolling contact, when the rolls are in work, but the distance is so slight, that the error is scarcely perceptible in practice; it also insures a reciprocity of motion; on the rolls becoming lesser in diameter by wear, the pinions become more accurately in gear.

The key-ways should be slotted.

Cane-juice Discharge Pipe.

This being of so simple a character, it need only be said the flange must be faced and the holes drilled.

Holding down Bolts Stop Plates.

These are to be cast clean, no filing or surfacing required.

Cane-juice Pump.

This should be in one casting in loam, accurately bored to receive the gland and guide bushes for plunger, the flanges faced and holes drilled.

Connecting Pipes.

These are of a simple nature, and need no description beyond that they should be fitted after the erection of pump and valve-box; flanges to be surfaced and holes drilled.

Pump Spur Wheel.

This should be cast clean, and the teeth pitched and trimmed, constructed as those already described to insure pleasantness of working with those of the pinion; the hole in the boss should be bored, and the key-way slotted to the required size.

BRASS OR GUN METAL. (PLATE 3.)

Valve-Box and Valves.

The casting of these should be perfect, as the least defect will cause a loss of vacuum, thereby partially losing the action of the pump, which should be capable of discharging the tank, equal to its supply. The valves should be turned and ground in their respective seats, and the provision for the door and its flange be well and truly planed and scraped, so as to make a perfect joint; the flanges of the supply and discharge openings should be truly faced, and all holes drilled throughout.

Gland Bush.

This should be cast longer by 3 inches than required, with a flange; it is bored and turned extremely smooth and driven tightly into the gland.

Plunger.

This should be cast perpendicularly, $\frac{1}{4}$th of an inch thicker than required, and from 4 to 6 inches longer at the open end, to insure a close and clean casting. It must be turned on the outside, and the hole for the eye bored centrally.

Pump Bush.

This should be cast clean, 3 inches longer than required, turned and bored smooth, and driven into its place tightly.

Bottom Roll Brass and Cover.

These should be cast separately, the cover got up bright, the oil cap and cover bored internally and turned externally, the ends of the brass faced and bored perfectly true at right angles with the ends, the waste part cut off after, at an angle of 45°, to allow the shaft to drop in its bearing, and then the cover secured in its place.

Top Roll Brasses.

These should be cast together, and after boring and facing, cut in two at the centre line; the fitting strips planed or filed, and the oil hole drilled.

Connecting Rod Brasses.

These should be cast in one casting, bored, planed, and shaped, oil hole drilled, cut in two at the centre, and finally finished bright.

Adjusting Screw Nuts.

These should be cast two-and-a-half times their required length to allow for planing and facing; the hole should be bored, and the screw cut on the inside to insure accuracy and discovery of defects before completion, after which divided transversely.

Top Roll Shaft Lubricator.

This should be cast clean and perfect, as the outside must be planed, also the bottom; the cover got up bright and hung in its place, the tube hole drilled.

Tube for Lubricator.

This may be of drawn brass, and cut to the required length.

WROUGHT IRON. (PLATE 3.)

Top and Bottom Roll Shafts.

These should be of the best iron, each forged soundly and clean, with an allowance of $\frac{1}{8}$th to $\frac{3}{16}$ths of an inch for turning; the part of the shafts midway between the keying provisions should be rough or black (as it is technically called); these keying provisions should be roughly turned; beyond these at each end the shaft should be turned bright, the key-ways for the rolls and pinions slotted, and the top roll shaft square at the pinion end for disengaging from the driving gear; care should be taken in keying the rolls that the keys at each end are not opposite each other, so that the intermediate key-ways in the roll at one end are opposite to the keys at the other, in order to drive back the keys with a steel bar, when requisite.

Square and Round Bolt and Nuts.

These should be forged perfect from the best iron, planed and turned where requisite for fitting and screwing; the screws to be cut in the lathe.

Keys.

These should be of the best iron, planed and fitted bright.

Stop Rings, Studs, and Pins.

To be of the best iron, turned bright on all sides, the top studs and pins to be turned and screwed in the lathe.

Stop Plates.

To be of the best iron, planed perfectly true, and holes to be drilled.

Cane-juice Pump, Connecting Rod, Cap, and Eye.

To be of the best iron, forged clean and perfect, turned and fitted bright, all holes to be drilled, the screw end of the eye to be cut in the lathe, the oil cup and the cap to be turned and drilled.

Discharge and Feed Table Plates.

These should be of the best plate iron, all holes drilled and tapped, and the discharge table plate bent to the required curve.

Spur Pinion and Crank.

These should be in one casting, bored and faced, after which the teeth pitched and trimmed, and the oil hole drilled.

CHAPTER IV.

VACUUM PAN. (PLATE 4.)

Dome.

The dome should be made from a solid, flat, circular block of copper, rolled to an uniform thickness, and by steam or manual power hammered on a curved anvil to the required shape, but less in depth and diameter, and greater in thickness, than eventually required. On leaving the rolling mills, it is, by hammering in the workshop, converted into the shape and dimensions specified. A small hole of about $1\frac{1}{2}$ inch in diameter is cut in the centre of the dome, and thereby slung by a chain attached overhead; by this means, the dome can be shifted on the curved anvil at any given point, the force of the blow decreasing in proportion to the completion of the process; planishing or polishing the surface is produced by gentle uniform blows with a highly-faced hammer, and, if properly done, it is a smooth surface of a high polish. Domes can be colored and polished by a red substance called Tripoli, but this is a matter of effect rather than utility.

Bottom.

The bottom is of copper, converted into its shape and dimensions, in the same manner as already described for the dome, but the inside of the bottom being required to be smooth for cleaning, &c., planishing is necessarily requisite.

Casing.

The casing is to be of cast iron of the best quality and workmanship, gradually and equally cooled to insure toughness and equal contraction, all bolt holes drilled, flange turned, and provisions faced.

Condenser and Receiver.

The condenser and receiver are in one casting, planed and faced where any joints are made, all holes drilled.

Arm Pipe.

The arm pipe is made from two sheets of copper, the seams to be well and neatly brazed, to run under and over the bend; flanges to be brazed outside the pipe, and holes drilled for connecting to pan and receiver; after which the entire outside surface of the pipe should be well and truly planished, and colored if desirable.

Worms.

The best process for the manufacture of the worm will be as follows:

A large board of about 9 or 10 feet square, well clamped at the ends, $1\frac{1}{2}$ inch thick, painted black, should have in the centre, on both sides, a brass plate of about $\frac{3}{8}$ths of an inch thick and 9 inches square, well secured in a recess by screws, the entire surface being level. Set off the centres of the coils in plan, obtained from the sectional elevation (as shown in the clarifier in Plate 9) from centres on the brass plate; the worm can be practically drawn full size, to the dimensions required; the length of plates to make the coil, should be about 5 to 6 feet, and the brazed seam should butt with dovetails equidistant, or lap joints $\frac{1}{6}$th of the diameter, each length being numbered and filled with lead, and bent to the requisite curves on the large black board; the mode of connecting is shown in Plate 5. The coil to commence from the lower end, temporary distance and supporting pieces being used in the copper bottom during the building of the worm, and when complete it is sustained in its place, as shown in detail in Plate 5. The worm should be well tested with steam of about 60 lbs. to the square inch previously to leaving the shop.

Bend Pipes.

Bend pipes should be of gun metal, taking care to make the pattern to fit in its place previously to casting, and a facing strip on the flanges connecting to the bottom and the dome; this will insure practically a good joint, without any undue strain on any part or parts, all bolt holes drilled, the joints to be made with cement and gauze wire.

The Measure.

The measure is usually made of copper from one sheet, cut smaller at one end, to produce the contraction at the top; the brazed seam should be of a dovetailed nature, as it tends to hold better; a band is put on about the centre to strengthen the body; the outer surface should be planished, and all joints of mountings made with cement, the loose cover at the top and frame being of gun metal; the frame is rivetted, or brazed to the copper; water surrounds the connection of the inside cover to insure a good joint; the top cover, besides, being ornamental, prevents the accumulation of dust on the water.

The Man Hole and Frame.

The man hole and frame are of gun metal; the covers, &c., are of the same design and principle as those of the measure already described.

Proof Rod.

The proof rod is entirely of gun metal, turned and fitted bright, shown half size in Plate 7.

Fig. 1 is a longitudinal section, except the rod C, shown solid from the handle to the lower end, which is in section; this end of the rod has a cavity drilled at a short length and plugged to close the end, which should be done previously to reducing the outer diameter to the proper size; after which, the plugged end might be brazed, so as to insure its not becoming loose; small, long, narrow openings are cut in the rod, turning plug D and casing E, as shown in Fig. 5 which is a transverse section. On the rod being turned by the handle, so that all the three openings agree in position, a portion of the sugar must run into the cavity of the rod; on reversing the action, the turning plug stops, or closes the opening in the casing, and the rod can be drawn. To insure its being withdrawn without breaking the vacuum in the pan, the nut B, Figs. 1, 2, and 3, has a hollow cast in it, having a slot on its top and a stop pin (shown in dotted lines) on the opposite side; the rod C having a pin screwed in it, this must go into the slot in the nut B, before the double stops in the rod C, Figs. 1 and 4, can fit into the slots in the plug D, which has a stop pin also, and works in a semicircular recess, seen in dotted lines in Fig. 1; by this means the rod cannot be withdrawn without closing the aperture. The flange casing A is secured to the dome by bolts and nuts, and the rod casing F is screwed into its place by the slots seen in Figs. 1 and 2, also showing number of bolt holes in the flange casing; the nut B prevents any looseness or leakage in the connections of the casings. Fig. 6 is an end view of the nut washer, flange and screws of the plug casing E, and turning plug D.

Light and Sight Glass and Frame.

The light and sight glass frames shown in Plate 7, are turned and got up perfectly bright, the glasses A being put in their respective recesses, and the joint made perfect with red lead, or cement; the holes for connecting it to the dome should be drilled, and the joint made with cement and gauze wire; all nuts to be on the inside.

Discharge Sluice Valve and Frame.

The required action of this valve is to stop or allow the egress of the semi-liquid sugar as it flows at any moment, also to be air-tight when closed. In Plate 6 will be seen a drawing of a sluice valve and frame, quarter size. Fig. 1 is a sectional elevation showing the discharge tube A, connected by bolts and nuts to the copper bottom B, which is supported by the casing C; the washer D, which is introduced for adjustment, and making a good joint; the frame E screwed on to, or around the discharge tube A, at the lower end; the valve F is merely a slide, thicker at one end than the other for the purpose of making a perfect joint when closed, and is guided by the slotted projections H; the frame must be in two parts for practical reasons—viz. fitting and scraping the faces against which the valve works; it will thus be understood that the lower part of the frame G is secured (after the fitting and scraping is completed) to the remaining part E, by studs and nuts as shown. The opening seen in Fig. 2 on the opposite side of the slotted guides is equal to the width of the valve, for the purpose of self-cleansing and clearing any sugar which might be deposited on the recesses during the discharging of the pan. Fig. 2 is half in transverse sectional elevation and half complete of the frame and valve. Fig. 3

is a plan, half section, half complete. Fig. 4 is a plan of a portion of the copper bottom and number of bolts requisite for securing discharge tube.

Heater or Heating Pan.

This pan is shown by two views in Plate 9, Fig. 1 being a complete plan, and Fig. 2 a sectional elevation. The copper bottom and casing should be made and connected in the same manner as that for the vacuum pan described in this Chapter. The band C, air cock D, safety valve J, and sluice valve F, are all the same in design, construction, and connection, as those of the vacuum pan. Steam is introduced between the casing and copper bottom by the cock E, and discharged by the cock I; the sluice is opened and closed by the handle H, giving motion to the rod G; the entire apparatus is secured to beams by four bolts and nuts as shown.

Clarifying Pan.

This pan is shown by two views in Plate 9, Fig. 3 being a plan, Fig. 4 being a sectional elevation. The worm C is constructed and connected in like manner to that of the vacuum pan already described. The top bend pipe of the worm is connected through the side of the copper bottom and cast-iron casing as shown, and supplied with steam by the cock E, which discharges the same by the cock J. The strainer G is separate from the pan, and prevented from shifting by a band of gun metal secured to the copper by small counter sunk screws; the discharge tube is secured to the copper bottom, similar to that of the vacuum pan; the two-way cock F is screwed on the discharge pipe in like manner; also the distance pieces and supports of the worm, centre lines of the worm being shown only in plan. The air cock K, condense cock J, and safety valve M, should be screwed into the casing; provisions P being cast on the side of the casing shown in dotted lines to receive the columns.

Melting Pan.

This pan is shown in two views in Plate 9, Fig. 5 being a complete plan, and Fig. 7 a sectional elevation; the pan is of cast-iron, cast hollow to receive the waste steam from the worm, which is of copper, made and secured like unto that of the vacuum pan, and secured at the centre by the bend pipe D. The bottom E is also of cast-iron, secured by studs and nuts to the pan. A small portion being in section in plan, to show the pitch of studs and the holes cast, to clear out the core necessarily used in casting, which should be in loam. This joint should be made with cement, as for the vacuum pan, &c. The strainer B is of gun metal, cast in segments, each being secured to a rim by one bolt and nut, cast with and projecting from inside the pan; by this means easy removal and economy in patterns are effected; one of these segments is shown in Fig. 6; this apparatus is secured by 4 holding down bolts, the holes of which are seen in plan.

Receiving Tank.

This is shown in Plate 9 in two views, Fig. 8 being the sectional plan, and Fig. 9 a complete elevation; it is entirely of cast-iron, made in separate parts for economy of patterns and practicability in casting; all the bolt holes are drilled; the liquor is drained from the tank by a cock being inserted at A.

section, half complete; the body A, the cover B, and the bottom C, are of cast iron secured to each other by bolts and nuts, the joints being faced, and made with red lead and oil; the float D is of copper, the guide, the valve, its seating, and rod, are of gun metal turned bright. G is an opening for the steam-pipe to be screwed into, H for a supply of water if required for condensation; the box is secured by nuts and bolts, the holes being seen in plan.

Divisional Tanks.

These tanks being of such a simple nature, both in design and size, the description will be brief; the following will be the mode of manufacturing:—Each should be in one casting when of medium size, or of 3 to 5 divisions, the holes to receive the brass bushes should be drilled, and the screw holes drilled and tapped, and counter sunk screws to secure the bushes, which are attached at the bottom to receive the discharge pipes.

Vacuum Pump.

This pump being highly essential to produce good sugar from the vacuum pans, great care should be observed in the design and construction, also accessibility to all the working parts. The means of working the pump are various; the beam engine with two pumps, intermediately between the steam cylinder and centre of the fly wheel being often adopted; also another mode is to work perpendicularly from cranks driven by steam or water power; gearing is usually introduced in order to give the required speed of the pumps. Horizontal action of the plunger to the perpendicular action of the valves is a good practical arrangement; these pumps should have a steam cylinder between each, the cranks so adjusted, or forged, that the steam crank be equidistant between the centres of each pump crank, the centres of which should be so arranged that the discharge or suction of the pumps should not respectively complete their actions at the same time; the stroke of the engine need not imperatively be equal to that of the pump, although a steadier action would be obtained by a long stroke, in proportion to the cylinder's diameter. In Plate 8 will be seen a vacuum pump, Fig. 1 being a longitudinal sectional elevation of the pump, trunk, piston valves, and boxes; Fig. 2 is a plan in section through the centre line, showing the suction valves in plan complete; Fig. 4 is a front elevation of the gland trunk and cover of the pump, also showing the brackets for supporting and connecting it to the steam cylinder; Fig. 3 is an end elevation of the valves box, showing the doors, bolts, and nuts.

The mode of manufacture will be as follows:—The body of the pump should be of the best cast iron accurately bored and faced at the flanges; the lining is of the best gun metal, turned and bored, when complete should be driven tightly into the body of the pump, the covers should be planed and turned as the case requires, all holes to be drilled, valve seats should be of gun metal cast clean, and free from any flaw or defects; the upper part and facing strip to be planed, all holes drilled, the studs in all cases to be tapped into their respective places, valve guards to be of the best gun metal, turned and fitted bright, and secured as shown. The valves are merely discs of vulcanized india-rubber.

Centrifugal Machine.

This machine is shown in Plate 11, Fig. 1 being a sectional plan, Fig. 2 the sectional

valve and case complete, invented by the author, and the following description as to manufacture and action, will enable the reader readily to understand both :—

Fig. 1 being a longitudinal sectional elevation through centre line. Fig. 2 a transverse sectional elevation through centre line. Fig. 3, a plan half in section, half complete. Fig. 4, plan complete.

The body A is of gun metal in one clean casting, free from any defects, the flanges faced, valve seats turned; the door B is of gun metal, also turned, faced, and holes drilled, the valve guide rod turned, and the guide bored, all bolt holes drilled; the equilibrium valve C and spring valve D are of gun metal, turned and ground in their respective places, all holes drilled, the connecting rods should be of the best wrought iron turned at the ends and screwed, the nuts should be of gun metal to prevent corrosion; the spring H is of steel tempered to a pressure of 14 lbs. per square inch on the valve D, taking friction into consideration; the adjusting guide-plate E to be of gun metal, planed, bored, and fitted bright, stay holes drilled, the stay rods and nuts G are of wrought iron turned and screwed. Having described the material and mode of manufacture, the action of the valve will be explained as follows—viz. the position of the equilibrium valve to that of the spring valve, should be open when the spring is extended to its greatest length, consequently on the high pressure steam entering the passage *a*, it rushes through the passages as indicated by the arrows, on reaching the spring valve D it causes a pressure on it, equivalent to its force, this valve being loaded to a pressure of 14 lbs. per square inch, gives way, or is pressed downward, causing at the same time (by the connection) the equilibrium valve to close in rotation, by this means curtailing the aperture in proportion to the pressure, and thereby lessening the supply of steam, which is reduced to the required pressure on leaving the valve casing at *b*. It will thus be seen that the action of this valve will be direct on account of its simplicity, dispensing with all stuffing boxes and the paraphernalia which valves of this class are usually burdened with, thus producing the great desideratum.

Scum Press.

This press is illustrated in Plate 11; Fig. 8 being a sectional elevation, Fig. 9 a plan complete. The press should be made in the following manner:—The body is of cast iron, it should be cast clean and free from defects or flaws of any kind, all facing strips to be planed or chipped and filed, the straining discharge holes drilled, the provision on the cast iron standard for securing the same should be planed, the nut hole bored (the nut is of gun metal of good material), the screw should be cut in the lathe, and the remaining part of the nut turned and faced on the under side, and the screw hole bored at right angles with the planed surface, the guide rods are of wrought iron, turned and faced, secured at the bottom end, the top ends with the nuts screwed in a lathe, the ratchet turning gear should be of the best wrought iron, with the exception of the spring, which must be of the best spring steel tempered to the proper degree; the whole of this should be turned and fitted bright; the holding down bolts, nuts, and stop plates are of wrought iron, all black.

Nosing and Shaping Machine.

As this machine is of a simple nature in form and number of details, the following will

and nuts to a cast or wrought-iron frame secured to the floor, or beams erected to receive it. The steam crane has a drum or pulley (having a screwed channel cast on its periphery to insure the regularity of the layers of the chain during its winding or unwinding) keyed on the crank shaft, which has a fly-wheel keyed on to it, also used as a brake wheel, with a band of iron having a wooden surface to act as a friction band; the lever of this band is attached to a rod or series of rods extending through the entire depth of the floors, in each of which is a handle accessible, or close to that of the reversing and starting gear.

Cask Steamer.

The case is made of wrought-iron plates well and truly rivetted together cylindrically, the top part being closed, of an elliptical or semicircular shape; supporting brackets should be rivetted at right angles to each other, midway from the top of the case, the lower part is open, having an angle iron ring rivetted on the outside, to secure temporarily the bottom made of cast iron, on which the cask is supported; this bottom should have a receptacle cast centrally in it to receive the liquid sugar. A safety valve should be secured on the top of the dome; a steam supply cock also on the opposite side. The chains made of wrought iron (for raising and lowering). These should work in pulleys overhead, and connected to the drum of the hand crane used as a prime mover to raise and lower.

CHAPTER VII.

Animal Charcoal Furnace.

This apparatus for producing animal charcoal is of the usual kind, no new feature being introduced simply from the reason that the present mode is a good one. Plate 13 shows views of a furnace for converting the bones of different animals into charcoal, which is used for the purification of sugar whilst in a liquid state.

Fig. 1 is a sectional plan. Fig. 2 is a transverse sectional elevation. Fig 3 a complete plan. Fig. 4 a longitudinal sectional elevation.

A denotes the several perpendicular retorts for containing the bones required to be burnt; B is the top or feed plate, on which the bones are placed preparatory to being put into the retorts, C the support plate for the retorts; D the plate to support the brickwork where the opening is required underneath each retort; F the frame and dead plate on which the fuel passes; G the fire bars; H the bearer bars; I the ashes box; K damper and frame for regulating the draught; J damper chain; L support brackets, pulleys and damper counterbalance; U the gas indicator; N the stays and bolts for supporting the brickwork; O the brick bridge to restrain the flame from the feed plate; Q the flue; R the chimney, which may be built to any required height, or from 20 to 30 feet from ground line.

The principal wrought and cast-iron work will be seen in detail in the same plate as the furnace. The cast iron part of this apparatus should be of a medium quality, clean and free

Worm Wheels.

Each of these wheels should be of cast iron of the best quality, the hole bored, and the key-way cut, the teeth to be pitched and trimmed.

Discharge Gas Pipes and Glands.

Each of these pipes are to be of cast iron, the inner one should have a loose flange screwed on it, to enable the end of the pipe to be put through the stuffing box, the remaining part of the pipes ought to be in one casting; all flanges to be faced, and the friction part of the pipe turned, the glands to be bored and turned, and all bolt holes drilled.

Gas Box Cover.

Each of these covers is in one casting, the hole for the clutch rod to be drilled.

Worm Shaft Supporting Brackets.

Each of these brackets is in one casting of the best quality, carefully and equally cooled to insure toughness, the facing strips to be planed, and the cap and body part bored to receive the brasses, which should be bored and faced; all stud and bolt holes to be drilled.

Worm Shaft.

To be of the best wrought iron, in length not exceeding 12 to 15 feet, to be turned at the bearings and provisions to receive the worm and sliding clutch, all the stop collars to be turned, bored, and fitted in their places, the coupling ends to be faced truly, and holes drilled.

Clutch Gear.

This gear in each case is of wrought iron, all holes to be drilled, and the levers and stays drilled and fitted securely in their respective places.

Front and Back Plates.

Each of these plates should be in one casting, cooled gradually, and free from any defects; all bolt and stud holes drilled and tapped.

Vertical Stay Girders.

Each of these girders should be in one casting, clean and free from any defects; the bolt holes to be drilled.

Tie Rods, Bolts, and Nuts.

These rods, bolts, and nuts, to be of the best wrought iron; the rods to be screwed at the ends, and the nuts screwed and faced.

Damper and Gear.

The damper frame and brackets should be of cast iron, and the levers, rods, stays, and handles, of the best wrought iron, fitted truly and well secured; all holes to be drilled.

Ashes Box.

Each of these should be of cast iron, of a clean casting, and free from any defects.

Fire Box, Door, and Frame.

The door and frame should be of the best cast iron, of a clean casting, and free from any defects, the holes drilled to receive the hinge bolts, which should be of wrought iron, turned and fitted with a stop key.

Fire and Bearing Bars.

Each of these bars should be of the best cast iron, of a medium quality, clean, and free from any defects.

Stop Plates and Shifting Discharge Door.

These should be of good plate iron, all holes drilled, and the edges of the plate filed smoothly.

Stops.

These should be made of the best wrought iron, handles turned, and the screws cut in the lathe.

Foundation for Column.

This should be of the best granite, free from any flaw, and resting finally in a bed of cement.

CHAPTER VIII.

ERECTING CANE MILL.

As the nature of the ground to be built on is the first consideration of the builder, great care should be taken to excavate to a depth sufficient to insure stability and permanency in the structure about to be raised. It would be better as a rule (particularly in ground of a sandy nature) to excavate from 3 to 4 feet below the intended commencing line, or bed of brick, or stone work; and should the subsoil be earth or sand, it would be advisable to drive piles from 6 to 8 inches square, to a depth that will insure its resting or bearing on a good firm substance. The position of these piles may be one in each angle, and the centre of the intended foundation, the piles being cut off level with each other; cross or tie pieces should be laid on them, and secured by spikes or screws; concrete composition as follows:—Of gravel 5 parts, of lime 1 part; these components being mixed with water to a stiff compound, should be well and truly laid on to a depth of from 3 to 4 feet, projecting at the sides 18 inches to 2 feet beyond the intended structure. This being allowed to settle and become hard will insure a good foundation for building the required brick or stone work on. Before commencing to build, care should be taken to set out perfectly square the margin or extremity of the brickwork; this being insured by the angles being found to measure equidistant across the centre, proceed to build as high as

the crown of the crough or key-holes of the holding down bolts, then lay on the two pieces of timber, through which the bolts will pass and the stop plates bear against. These timbers should be enclosed within the brickwork, and laid accurately parallel. The position of the bolt holes must agree from the centre of the brickwork with that of the bed-plate; a template of the centres would insure accuracy, and a saving of much time. Staves 6 or 7 feet long, $2\frac{3}{4}$ inches square at one end, and tapering to $2\frac{1}{4}$ inches at the other, so as to draw easily; each bolt is represented in the brickwork by one of these staves; the correctness of their being perpendicular during the building should be occasionally tested by a plumb-line. The set-off for the cane-juice tank should be built and the timbers laid on. Having proceeded with the termination of the brickwork to its required height, put the cane-juice tank in its place, draw the staves, and set on the wood frames to receive the bed-plate of the mill, and complete the brickwork between the wood frame. The bed-plate should be slung on, and set, so that all the holding down bolt-holes agree, which being the case, put the bolts in their respective places, also the stop-plates and keys; the entire structure should now be allowed to settle and dry for a period of a few days, or according to the temperature of the climate. Presuming the foundation to be permanently settled and dry, the process of erecting the mill should be continued as follows:—First ascertain if the bed-plate be truly level, if not, it must be lifted off the wood frame, and the wood cut away at the required places; this having been done, and the bed-plate found to lay level, the side frames of the mill should be put on the bed-plate, and secured by the holding down bolts and nuts; each bolt should be secured at the same time, and tightened, so as to insure an equal strain, and the mill remaining truly level, which is the great preventive of increased or undue friction of the working parts; the top and side bolts, brasses and adjusting bolts, should be put in their respective places, also the shafts having the rolls keyed on them. The cane guide or returner might be next fixed; but this is not imperative, it being so made and attached as to be removed or replaced without any disarrangement of the surrounding parts of the mill and shaft. The top roll shaft being put in its brass bearings, the top brasses, cap, and bolts, can next be fixed, the distance pieces secured, and the feed delivering tables adjusted. It is not imperative that the gearing or spur pinions should be keyed on their respective shafts preparatory to erecting; it can be done as effectually and accessibly during the course of erection as before, on the principle, that if by accident a tooth of one pinion should break, the mill should be disarranged only in that particular part, and the incapacitated wheel or pinion replaced by a new one. Lastly, secure the juice discharge pipe.

Having thus described the proper mode of erecting the mill, it is next essential to explain the use of the tank and pump, seen in section in Plate 1, Figs. 1 and 2. The cane on being put into the mill becomes pressed or squeezed, and exudes the juice called liquor, which flows from the bed-plate into the tank, already erected and secured. When the bed-plate of the mill is level with the ground line, it is necessary to have a pump to force the liquor into the clarifiers. The body of the pump having been fixed to the end of the tank, the connecting supply pipe should be next secured, after which the valves box, the valves being put in their seats before or after. The crank and gearing for working the pump being now keyed on and fixed, the connecting rod should be secured to the plunger, it being now in the pump, and the stuffing

Receiving Tank.

This tank, whether made of cast or wrought iron, is of sufficient weight to insure its rigidity without bolts or any other means to secure it.

Expansion Valve Box.

This valve box and fittings being of light weight can be secured either by bolts and nuts to a slight beam, or supported by the connection to the steam pipes.

Scum Press.

This press should be erected in the following manner:—The body having been secured perfectly level by the holding down bolts and nuts, the press plate should be put in the receiver, and the guide rods and screws secured; the standard and nut must next be adjusted, and the ratchet for turning the nut secured, which will complete the erecting process.

Nosing and Shaping Machine.

This machine should be completed previous to erection; each of the holding down bolts and nuts passing through a beam must be tightened at the same time, to prevent any undue strain; care should also be taken that the machine is perfectly level when erected.

Shaving Machine.

This machine should be erected in the same manner as the nosing machine.

Pulling-up Machine.

This machine must be erected very rigid, having to bear an unequal strain due to its varied motion. The foundation of the steam crane should be of timber beams, secured by bolts and nuts, one end let or built in the wall and the other to the beams of the floor; the tops of the frames must be stayed by bolts and nuts to a timber or iron structure, so as to prevent the least oscillation. The minor details of the machine should be connected to each other previous to final erection, insuring thereby facilities for exactitude in connection with its remaining parts. The reversing, stopping, and brake gear should be erected with care and precision, as the exactitude of their duties depends entirely on the rigidity of the parts. Timber uprights with cross tops, stayed by wrought-iron bolts and nuts, should be attached to each floor for the purpose of securing the brackets for the different handles; by this means the entire apparatus will be certain in its action.

Erecting and Connecting Vacuum Pan.

The different details of the vacuum pan, and the mode of manufacturing them, having been described in Chapter IV., a description of the best practical mode of connecting and erecting will now enable the reader to more clearly understand the application and use of the vacuum pan (described in Chapter I.). The wrought-iron band should have the bolt holes drilled, the flange of the casing turned and surfaced, the copper bottom having the sluice tube secured to it by bolts and nuts, and a little liquid cement to make the joints, also the bend pipe

connection being made of india-rubber of at least $\frac{1}{32}$nd of an inch in width, and secured with screws. A piece of white cardboard should be introduced at the back to enable the index being clearly seen.

Valves and their Seatings.

All valves should be of gun metal of the disc-like form, with 3 ribs to act as a guide; the air valve is opened and shut by a small crank moved by a lever on the outside of the condenser. The steam stop valve is so arranged that the steam is always pressing on the valve whether open or shut; it can be raised or lowered by a screw on the inside below the stuffing box, and worked by a handle or small wheel on the outside.

Vacuum Pump and Engine.

Any machine or machinery, however good and practical in design and workmanship, will become useless prematurely from bad or imperfect foundation and erection; in no part of the apparatus used in the process of making sugar should greater care and attention be bestowed than on that of the vacuum pan, which, however well manufactured and erected, is subservient to the vacuum caused in it, thereby entailing responsibility on the means adopted, whether by fall of water or action of pumps (the best known method at present). Chapter V. describes the most efficient mode of working and manufacturing the vacuum pump.

It is now essential to give a good practical mode for permanently erecting and securing it to a good foundation. The foundation of the engine and pumps should be in one mass, either of brick or stone, timber beams being built within the brickwork at the required height to secure the holding down bolts and stop plates, the masonry should be completed, and the top timbers laid on which the bed-plate of the engine and pump has to rest. After the masonry has well and permanently settled, the bed-plate should be secured perfectly level in its place, after the manner described in this Chapter, for that of the bed-plate of the sugar-mill. The steam cylinder should next be secured between the pumps, and the connected mass finally fastened by the bolts and nuts to the bed-plate. The valve boxes with the intermediate pipes connected may next be put on their respective places; after which, the crank shaft secured in its bearings. The pistons and trunks are next put in their respective cylinders (a trunk engine can be used), the covers being next secured, and joints made; the stuffing boxes should be packed and the glands secured, connecting and eccentric rods should be connected and adjusted, and the minor details put in their respective positions and places. All pipes should next be connected, taking care to make the joints perfect. This description of engine and pumps is extremely simple and effective in its duties, and economical in working.

Centrifugal Machine.

The foundation of this machine is usually of brickwork, built with set-offs at the bottom, and rising perpendicularly at the sides to a height of about 3 feet 6 inches to 4 feet; the holding down bolts and beams are inserted and laid, as for the sugar-mill already described. The machine is generally complete before erection, and the precaution that the brickwork is well set previous to finally securing should be observed. The top timbers must be cut or chipped

to the front and back plates; these girders are secured to the columns by the securing bolts and nuts, the bolts being keyed tightly in the columns. The fire-brick bridge being in one piece, should be next laid in its place, the supporting brackets centrally adjusted and secured by the keys, bolts, and nuts, to the back and front, and supporting girders in the following manner:—A piece of wood is inserted centrally in the opening in the front and back plates, also in each bracket a piece of wood resting on each brass; these respective pieces of wood are marked transversely centrally, a truly horizontal line being suspended centrally through the furnace, and intersecting or resting on the marks on the wooden pieces already mentioned, will insure the bearings being true with each other by adjustment; the front bracket is then carefully marked and taken down, and all the wooden centres knocked out. The retort should then be lifted in its place, the back end being supported by the bracket, secured there, and the front end by a lifting jack. The front bracket having been finally secured in its place to the marks before mentioned, the lifting jack should be taken away, when the retort will be found to revolve centrally and level in its bearings. The worm shaft supporting brackets should be next secured by the bolts and nuts to the girders. The ends of the retorts being secured by the studs and nuts, and the worm wheels keyed on the provision cast to receive them, the covers laid on the gas boxes, the worm shaft and clutch gear erected and adjusted, after which the damper and gear secured, the discharge gas-pipe being in its place in the back ends of the retorts. The stuffing box should next be packed, and the remaining part of the pipes secured, the stop-plates and shifting door also secured, and the fire bars laid; the entire apparatus is now complete for use.

CHAPTER IX.

COLONIAL BUILDINGS.

Buildings for Colonial purposes differ entirely from those at home, in consequence of the continuous sultry climates, the liability to hurricanes, and the necessity for economising human labour. Colonial houses or buildings are rarely made more than one story high from the ground-floor, and in many instances the manufacturing processes are entirely carried out on the ground-floor, with raised platforms at the required places, or in some cases mount juices and pumps elevate the liquor from one vessel to another; such a process is detrimental to the liquor, as the less it is agitated artificially the better. The best form in plan for the Colonial house, is to commence with the crushing at one part or end of the building, and continue with the arrangement direct, until completion to the store or warehouse. (A good form of house and convenient arrangement of machinery, designed by the author, is shown in Plate 15.) The height of the Colonial house or houses being low in proportion to the Home buildings,

more or less, to suit the taste; the height of the floors should be from 8 to 10 feet, or not less than 7 feet; the walls from 3 to 3 feet 9 inches at the base, decreasing to 1 foot 6 inches at the top, and 8 or 9 floors high. Refineries in England of note range from 70 to 100 feet in height, and from 8 to 12 floors; the girders for supporting the floors should be of cast or wrought iron, of such sectional area in proportion to its length and weight, as to sustain at least 6 times the breaking strain. The floors should be made of deal planking, well seasoned and evenly laid, and secured by bolts and nuts, or screws; tie rods are sometimes used to insure the walls of the buildings from giving out; but, although this precaution may be adopted, it should not be entirely essential, the walls being of a sufficient thickness to insure permanency. In Plate 16 will be seen a sugar refinery embracing every improvement designed by the Author.

Timber Work.

This class of material for construction is becoming less used for building purposes, but, as it predominates in the Colonies, from economical reasons it is often used. All wood used for windows, roofs, beams, floorings, platforms, or foundations, should be well seasoned; when green or wet wood is strained it becomes weaker as it dries, being more elastic than when seasoned, and the strain continuing at the same time as the contraction or drying of the fibre, it must necessarily become weaker. All platforms and the wood used, for the supports, should be well painted, also all connections before completion, care being taken to select the pieces free from knots or flaws for bearing the greatest strain. So many different kinds of wood being used, it is difficult to give a rule or data that will answer for all; practical experience is the best guide, and from that only can true and tangible results be obtained. All beams of wood should be a parallelogram in section, the depth being $1\frac{1}{2}$ times the width as a general rule; the length should not exceed more than 10 times its depth without support, but as circumstances alter cases, particularly in this instance, the weight should be the constant number used in calculation. Joists should be in depth $3\frac{1}{2}$ to 4 times their width, and supporters or beams 1 foot square for every 15 feet in length, on the provision that a good material be used.

CHAPTER X.

SUGAR MILL.

The size of this mill is governed by the amount of cane-juice required in a given time, or the amount of sugar to be produced per diem; the rules annexed are gained from experience; they will be found to be practical and correct, both as to utility and design. The first consideration of the designer or maker of any machine or structure should be to ascertain its intended object; consequently, in the case of the sugar-mill, the first step previous to designing is to decide or ascertain the amount of work to be done in a stated period. It has been proved from practice that rolls from 2 feet diameter, having a superficial surface of from 3 to 4 square

inches per gallon per hour, are of good proportions, and in extreme cases, such as mills with rolls 30 inches diameter and 60 inches in length, 2 to $2\frac{1}{2}$ square inches per gallon per hour would be the average amount of surface required. Thus divide the number of gallons required in one hour by the number of square inches decided on, the quotient equals the surface of the roll. But the principal guide is the cane as to its richness and ripeness, &c.; a mill should in all cases be of maximum power.

Top Rolls.

This roll has to bear the greatest strain, for the following reasons:—The cane on being first put into the mill is nipped by the rolling action of the top and that of the side roll, thereby causing the cane to be pressed and propelled, also guided by the cane guide to and between the top roll and the roll on the opposite side, thus squeezing the cane a second time. As this process should be continued without interval during the working hours, the top roll and its shaft has a constant thrust or strain in a line or angle with its centre and that of the two side rolls, both acting at the same time; whereas, in the case of the side rolls, each receive their strain at one angle only—viz. from the top roll centre to their respective centres. The diameter of the roll is not imperative, but practically, a larger diameter will crush more cane and more effectually than a lesser, for the reason that the larger the curves of the periphery of the circles in contact, the less liable to cut the cane; therefore, by pressing or squeezing only should the juice be extracted. The length of the roll should be twice its diameter. The thickness of metal in the centre $\frac{1}{5}$th of the diameter. Thickness inside keying bosses $\frac{7}{8}$ths of that of the centre. Inner diameter of the keying bosses $1\frac{1}{5}$th of the diameter of the shaft at that part. Width of key-ways $\frac{1}{4}$th of the diameter of the shaft at bearings. Depth of key-ways $\frac{1}{2}$ their width. Length of keying bosses $\frac{5}{8}$ths of the shaft's diameter at that part; the end of the keying boss is usually within the end of the roll, but this is not imperative.

Bottom Rolls.

Diameter, equal to the top roll. Length, twice its diameter, adding $\frac{1}{2}$ inch for clearance. Width of the flanges at each end $\frac{1}{26}$th of the diameter. Depth of the flanges $\frac{3}{4}$ths of the width.

Top and Side Roll Shaft.

Length, subservient to the position of the side frames; but usually the inside end of the bearings are 1 inch to $1\frac{1}{4}$ inch from the end of the top roll. Diameter of shaft at the bearing, $\frac{1}{3}$rd of the diameter of the roll; an increase of $\frac{1}{10}$th of the diameter of the bearing for that of the top roll. Length of bearings: $1\frac{1}{4}$ the diameter of bearing will insure sufficient strength. Diameter of collar or shoulder of the bearings equals $1\frac{1}{5}$ of the bearing's diameter. The depth. of the key-ways should be $\frac{1}{5}$th of their width, thus giving the diameter of the keying provision, the bottom of the key being in a line with the diameter of the shoulder or collar. The square end of the top roll shaft should be as large as the diameter of the shaft will admit; the usual mode of disengaging is to key a clutch on the mill shaft, or provisions cast on the top of spur pinion, a sliding clutch being on the spur wheel shaft to fit into that of the mill. A good practical method is to allow the sliding clutch on the spur wheel shafting to slide direct on to

that of the top roll, thus preventing any strain on the keys of the spur pinion, also dispensing with a clutch on the roll shaft or pinion.

Side Frames.

A certainty for insuring strength in these frames is to make them of wrought iron; but the expense of the material is at present a great barrier to its introduction; the frames should be of great strength, having to sustain the weight of the rolls, shafts, tables, returner, bolts, &c., besides the strain produced during the working of the mill. The sides of the square of the sections of the different parts of the frames should equal the shaft's diameter, the width of the frame being increased $\frac{1}{8}$th or $\frac{1}{9}$th of the side; but being of a peculiar shape and subject to defects in casting, it must (as before mentioned) be of great strength. The width of the facing strips should be $\frac{1}{6}$th of the part to be connected, and the recess between the strips $\frac{1}{8}$th to $\frac{1}{4}$th of an inch; the size of the key and bolt holes are of course subservient to the keys and bolts. Cap in depth equal to $\frac{3}{4}$ths of its width.

Top Roll Brasses.

The top and bottom parts of the brasses should be in thickness $\frac{1}{4}$th the diameter of the bearings. Thickness at the side $\frac{3}{4}$ths the thickness of the top and bottom.

Bottom Roll Brasses.

These brasses having no strain on the top are open at that part, and having to receive the strain, which is direct through the centre connecting line of the shafts, the thickness of the brass should be equal at the sides and bottom to $\frac{1}{5}$th of the diameter of the bearing, for the purpose of adjusting the roll, &c.

Top and Side Bolts, Rings, and Stop Pins.

These bolts receive the strain of the rolls, and if not of sufficient area in section, entail the fracture of the side frames. The area of the side bolts at the bottom of the thread of the screw should be $\frac{1}{5}$th of the area of its respective shaft's bearings and sectional area. The area of the top roll bolt should be $\frac{1}{8}$th of its respective shaft bearing sectional area; the screw should in both cases be flat threads, the pitch of the screw $\frac{1}{7}$th to $\frac{1}{8}$th of its diameter. The thickness and space of thread are equal. The size of the top roll bolts and nuts across the angles should be twice the diameter of the bolts, and the depth equals the diameter of the screw, the stop rings being for the purpose of stopping the nut or bolt from becoming unscrewed; symmetry takes the place of strength, consequently any rule given will entirely depend on the taste of the maker or designer. The width and depth of the ring of the top bolts may be $\frac{1}{3}$rd of the diameter, the width of the ring for the adjusting bolts may also be $\frac{1}{3}$rd of its diameter, and the depth $1\frac{1}{4}$ the width. Stop pin's diameter $\frac{1}{6}$th to $\frac{1}{8}$th of the bolt's diameter; the distance of the top roll bolts from centres equals twice the diameter of shaft's bearing.

Cane Guide.

This guide, having to bear an unequal strain, should be made of great strength. The width

of the guide is imperative or subservient to the position of the rolls. The thickness of the guide should be $\frac{1}{10}$th of its width. The width of the boss at each end twice the diameter of the adjusting bolts—depth of the boss $\frac{3}{4}$ths to $\frac{7}{8}$ths of its width; depth of the rib in the centre of the guide equals depth of boss; the straining holes are $\frac{3}{4}$ths to 1 inch in diameter; the diameter of the adjusting bolt $\frac{2}{3}$rds of the diameter of the top roll cap bolts.

Top and Side Roll Pinions.

These pinions should be of great strength, on account of the variation in thickness of the sugar-cane. The diameter of the pitch circle should in every case equal the diameter of the rolls; the pitch of the teeth should be $\frac{1}{7}$th of the diameter of rolls; but the exactitude of this cannot be in all cases, on account of the diameter of the pitch circle being imperative. The breadth of the teeth should be $2\frac{1}{2}$ times the pitch. The length of the teeth must be $\frac{7}{8}$ths of the pitch. The clearance should not be more than $\frac{1}{32}$nd of an inch to each inch of the pitch. The distance of the top and root of the tooth from the pitch circle should be nearly equal, as the periphery of the rolls when in position for working do not touch, consequently a clearance is secured between the top and roots of the teeth of the respective pinions. The metal of the boss of the pinions should be $\frac{1}{3}$rd of the diameter of the roll shaft, the thickness of the ribs and rim equals that of the teeth. The width of the key-ways should equal $\frac{1}{4}$th of the diameter of the shaft. Depth of the key-ways $\frac{1}{2}$ the width.

Bed Plate.

This part having to sustain the weight of the entire mill, it must necessarily be made of maximum strength. The following rules will insure to the maker sufficient material throughout the entire casting:—The strips on which the side frames rest (and are secured) should agree with the same; the thickness of the metal equals about $\frac{1}{25}$th of the diameter of the roll; the bottom, sides, and top should be equal. This rule is not imperative, as small mills require in proportion more strength than large. The depth of the bed plate in the inside should equal the diameter of the discharge pipe, and the area of this pipe equal one square inch per square foot of the surface of the top roll; this will insure sufficient area for the cane-juice to flow through. The thickness of the metal around the bolt holes should be half the diameter of the bolt. The thickness of the ribs should be 1 to $1\frac{1}{4}$ of the metal of the bed plate. The diameter of the bosses to receive the nuts should be $2\frac{1}{8}$th of the bolt's diameter.

Distance Pieces.

The length of these should be $1\frac{1}{3}$rd of the diameter of the bearing of the side roll shaft. Thickness of metal around the recessed bolt holes equals half the bolt's width.

Supply and Feed Table Brackets.

These brackets being of a peculiar form, no stated data can be given. The best mode for ascertaining their shape is to set out the angle of the tables, viz.—angle of 60° for the supply table, an angle of 45° for the discharge. This having been done, the brackets may be designed according to taste to fit the adjusting provisions on the side frames; the thickness of the metal

of the brackets should not be less than half an inch for the small mills, and $\frac{3}{4}$ths to $\frac{7}{8}$ths of an inch for mills of an extreme size, $\frac{5}{8}$ths of an inch being generally used; the depth of the side ribs should be from 3 to 5 inches at the highest point, tapering to the outer $\frac{1}{4}$ inch per foot.

Cane-juice Tank.

This tank being of a simple nature, both in form and construction, the requisite data will be as follows:—The contents above the strainer about $\frac{1}{10}$th of the amount of juice exuded in an hour. The thickness of the metal of the sides $\frac{3}{4}$ths to 1 inch. The thickness of the bottom and flanges $1\frac{1}{8}$ of the side. The strainer is in some cases of gun metal, but the cost is an objection to its being in general use. Cast iron answers the purpose as far as strength is concerned, but its corrosive nature lessens its utility in this instance. The holes for straining the cane-juice should be oblong in shape; size $\frac{1}{8}$th of an inch in width, and 1 to $1\frac{1}{2}$ inches in length. Pitch of holes 1 inch, and 1 inch of metal between them longitudinally. Pitch of bolt holes 8 times their diameter.

Cane-juice Pump.

This pump has to discharge the juice from the tank as fast as it flows. The strainer should always be covered with the juice to a depth of 4 inches, so as to prevent any crushed cane going through it during the action of the pump. The speed of the plunger should be 25 to 30 feet per minute; when the diameter is about half the stroke this will give a speed of 4 to 1 of the mill, which will insure the action of the valves; if the speed of the pump be slow, the action of the valves being subservient to it, a great loss of power is sustained, also if the speed be too quick. The contents of the pump will be obtained as follows:—To the amount of juice exuded from the cane per hour add 5 per cent. for loss of action, that sum, divided by 6.25 (being the number of gallons in a cubic foot), will give the cubic contents per hour, which, being divided by 60 (minutes), gives the cubic contents per minute; divide by half the number of strokes of the pump per minute, the product will give the cubic contents in feet, from which obtain the diameter and length of the stroke, the proportions of which are given.

Valves and Box.

The area of the valves should be $\frac{1}{2}$ to $\frac{5}{8}$ths of that of the plunger, as the tenacity of the cane-juice slightly impedes their action, therefore requiring ample area to discharge through. The thickness of the valve should be $\frac{1}{8}$th of its diameter at the bottom of the cone, and the angle of the cone 45.° Lift of the valve in all cases $\frac{1}{4}$th of its diameter. Length of the ribs $1\frac{3}{4}$ to 2 of the lift. Thickness of the ribs $\frac{1}{4}$th of that of the valve. The thickness of the metal of the body of the valve box should be $\frac{3}{64}$ths of an inch per inch of the diameter inside at the largest part. The thickness of the necks of the supply and discharge parts should be $1\frac{1}{4}$ of that of the body. The thickness of the flanges $1\frac{1}{4}$th of that of the necks. The pitch of the bolts must in all cases equal 8 times their diameter. Thickness of the door equal to that of the body.

Spur Wheel and Pinion, &c., for Working Cane-juice Pump.

Pitch of the teeth half of that of the roll pinions. Length, $\frac{3}{4}$ of the pitch. Breadth, $2\frac{1}{2}$ times the pitch. Clearance, $\frac{1}{32}$nd of an inch per inch of the pitch. Thickness of the rim

equal to that of the teeth. Breadth of the arm at the rim, $1\frac{3}{4}$ of the pitch of the teeth, tapering larger to the boss 2 in 12. Diameter of the boss, twice that of the hole. Diameter of the pinion shaft, $1\frac{3}{4}$ of the pitch. The crank and pinion are in one casting. Diameter of the crank pin $\frac{2}{3}$rds of that of the shaft. Diameter of the crank end of connecting rod equals that of the crank pin. Diameter at the plunger end equals that of its pin, which should be $\frac{7}{8}$ths of the diameter of the crank pin.

Pipes.

The thickness of the metal must equal $\frac{1}{10}$th to $\frac{1}{12}$th of the diameter inside. Thickness of the flanges $1\frac{1}{4}$ of that of the pipes.

Holding-down Bolts.

The diameter of these entirely depends on the number used, which is usually three in each side frame. The area of each bolt should equal $\frac{1}{2}$ the area of one of the cap bolts at the bottom of the thread of its screw; the length of course depends on the amount of masonry and woodwork underneath the mill, but an approximate length between nut and cotter is $3\frac{1}{3}$ to $3\frac{1}{2}$ of the top roll's diameter; when the length exceeds this, the area should be more in proportion.

Masonry and Woodwork.

The weight of the mill tends practically to sustain its equilibrium, but a good solid foundation insures rigidity. The following approximate rules will enable estimates to be made with the certainty that the maximum is given:—

The depth of the brickwork underneath the timber frame should equal the length of the roll, but an inch or two more or less, to retain an even dimension or use in bricks, will not be material. The beams for the stop-plates to bear against, should be in thickness 4 times the diameter of the bolt, and in width 3 times its thickness; the length is subservient to the position of bolt holes. The top frame should be well dovetailed together, halving each piece, the side of the square of each beam should be 6 times the diameter of the bolt, and for the centre bolt a piece equal in thickness to the frame should be secured by bolts and nuts.

Power.

The true definition of this word implies the amount of force (of any kind) to overcome a given amount of friction; could that amount be correctly obtained and the standard kept, the requisite power would be fixed in proportion, but in practice the uneven friction due to the inability and carelessness of the different attendants, render it imperative that a certain amount of supplementary expenses must be incurred at the commencement, in procuring sufficient strength of material and power to overcome the evils above mentioned.

The nominal horse-power requisite for a sugar-mill of any given size, taking into consideration all contingent liabilities, will be deduced from the following rules:—

The speed of the periphery of the rolls should be about 18 to 21 feet per minute; the speed of the piston of the engine should be 200 feet per minute; the motion of the engine

being greatly in excess of that of the mill, the latter is reduced by spur gearing in the following manner:—A pinion keyed on the crank shaft works into a large wheel, thus partially reducing the motion; on this wheel shaft a small pinion is also keyed, which works into another large wheel, thereby reducing the motion to the desired speed; on this last shaft a sliding clutch is fitted, which connects to the top roll shaft of the mill when required. The surface of the rolls is the chief consideration, as from these the amount of power requisite should be obtained. It is obvious in practice that the surface of the rolls of a large diameter has more friction in proportion than that of a smaller, for the following reasons:—When two surfaces are in contact, the nearer each is in shape to a plane or straight line, the greater the amount of friction, owing to the surface in contact. Again, when two bodies are in contact, and a third has to pass between them, the less acute the angle of the surfaces from the point of contact the less friction the three bodies will incur during the movement. The application of a constant number in all cases would be impracticable. The following rule will be sufficient to enable planters and makers to produce the desideratum, taking into consideration a reduction of speed and friction:—Mills having the surface of their top roll to equal from 20 feet superficially, require one-horse power to 2 feet of the surface; whereas rolls with 40 feet of surface, superficially, require one-horse power to $1\frac{1}{2}$ square feet of the surface, thus enabling intermediately the proportion to be obtained. The rules and proportions of the sugar-mill being now completed, those of the vacuum pan will next engage our attention.

CHAPTER XI.

VACUUM PAN.

The process of manufacture, and mode of erecting and connecting the vacuum pan having been described in Chap. VIII., it will now be essential to give the rules and proportion of the pan, and its appendages; the following will be found correct, both as to symmetry and strength:—

Dome and Bottom.

Height of the dome equals $\frac{2}{5}$ths of the inside diameter; depth of the bottom equals $\frac{1}{3}$rd of the diameter. The form of the dome and bottom in section should be curves, drawn from three centres, thus:—The radii for the curve commencing from the flange equal $\frac{9}{10}$ths of the height and depth respectively; the centres of this radii being on the face line of the flanges, the larger curve is drawn from radii that will cause an intersection symmetrically with the side curves, and height and depth of the dome and bottom. The flanges are usually $\frac{1}{4}$th to $\frac{3}{8}$ths of an inch thick, the medium size being generally used; the width is five to six times the diameter of the bolt used. Thickness of metal at the sides, commencing below and above the

flanges, $\frac{4}{5}$ths of that of the flanges. Thickness of the top of dome $2\frac{3}{4}$ths of that of the sides. Thickness of the lowest part of the bottom three times that at the sides.

Casing.

The depth of the casing will be given by the space between bottom and inner parts of the casing, which should be $\frac{1}{8}$th of the depth of the copper bottom. Diameter inside the casing should allow a space between it and the copper from $\frac{3}{16}$ths to $\frac{5}{16}$ths of an inch. The radius of the curve of the bottom inside, centrally, should be $\frac{5}{6}$ths of the inner diameter of the copper part of the pan; the curves for the side are to be drawn from radii, whose centres should be on a level with the face of the flange. Thickness of the body of the casing from $\frac{5}{64}$ths to $\frac{1}{8}$th of an inch per foot in diameter. Thickness of the flange $1\frac{1}{8}$th of that of the casing. The raised projections on the flange (making a recess to receive the cement) should be as follows:—The outer projection in depth and width $\frac{1}{4}$th of the thickness of the flange, the inner, in depth, equals that of the outer, and twice the depth in width. The width and depth of the supporting brackets should be $\frac{1}{9}$th of the pan's diameter, the position of these brackets, front, back, and sides, are to be at right angles, depth from face of the flange should be $\frac{1}{5}$th to $\frac{1}{6}$th of the pan's diameter, thickness of the ribs equals that of the body, the thickness of the bottom part of the bracket $1\frac{1}{4}$th of that of the ribs. Diameter of holding-down bolts from 1 to 2 inches. Thickness of the metal of the distance projection inside the casing is the same as that of the body, the diameter $\frac{5}{6}$ths of the outer diameter of the discharge tube.

Arm Pipe.

Diameter at the neck $\frac{1}{5}$th of that of the pan. Diameter at the end $\frac{3}{4}$ths that of the neck. Length from the centre of the neck $\frac{1}{2}$ the diameter of the pan. Height from the flange to the centre line equals the diameter of the neck.

Worm.

The surface should equal 1.5 to 1.75 of a square foot, to one cubic foot of sugar to be boiled at once; thickness of metal $\frac{1}{8}$th to $\frac{3}{16}$ths of an inch. Distance between the coils $\frac{1}{2}$ to $\frac{1}{3}$rd of the diameter of the worm. Distance of supporting stays equals the height of the worm from the bottom.

Condenser.

The cubic contents should equal that of the worm. Inner diameter equals $\frac{1}{5}$th of the diameter of the pan. Thickness of the metal $\frac{1}{16}$th of an inch, per inch in diameter.

Receiver.

The cubic contents should equal $\frac{1}{2}$ of that of the condenser. Diameter equals $\frac{7}{8}$ths of that of the condenser. Thickness of metal equals $\frac{1}{16}$th of an inch, per inch in diameter.

Measure.

The cubic contents should equal $\frac{1}{8}$th to $\frac{1}{16}$th of the amount of sugar to be boiled at once, or a skipping. Diameter equals $\frac{3}{16}$ths of the inner diameter of the pan.

The mode of constructing the shape of the measure will be thus:—Having determined the diameter and length of the measure, the bottom should be drawn with the following curves:—The largest radius equals the diameter at the centre, the smaller radii top and bottom equal $\frac{1}{4}$th of the diameter at that part; when the sides of the measure are curved the diameter at the ends must be $\frac{32}{36}$ths of that of the centre. The diameter of the top should be about 12 inches, for accessibility to cleanse the inside.

Sugar Discharge Sluice Valve.

The diameter should equal $\frac{3}{4}$ths to 1 inch per foot of the pan's diameter.

Injection Cock.

The area should equal 1 square inch, per 19 to 20 square feet of surface of the worm.

(Condenser) Discharge Valve.

The area should equal 6 to 7 times the area of the injection cock.

Charging Cock.

The diameter of this cock is usually from 2 to 3 inches.

Vacuum Cocks.

These cocks should be from 1 to $1\frac{1}{4}$ inch in diameter.

Air and Gauge Cocks.

The diameter of these cocks should be from $\frac{1}{2}$ to $\frac{3}{4}$ths of an inch.

Safety Valve.

This valve should be loaded to a pressure equal to 14 lbs. per square inch.

Supply Steam Valve.

The area of this valve should be $\frac{3}{4}$ths of the area of the inner diameter of the worm.

Discharge Steam Cock.

The area of this cock should be $\frac{1}{4}$th of the area of the supply steam valve.

Man Hole.

The diameter should be 16 inches, position from centre line of pan opposite to that of the arm pipe. Distance of the centre of the man hole to the centre of the pan is not imperative; but $\frac{1}{3}$rd to $\frac{3}{16}$ths of the pan's diameter will be an uniform position.

Light Glass Frame.

The diameter of the opening should be 4 inches.

Sight Glass Frames.

The diameter of the opening should be $2\frac{1}{4}$ inches. The light, sight, glasses, and frames are illustrated half size in Plate 7, and are practical examples. The position of these frames on the dome should be about 3 feet 6 inches from the floor line.

Proof Rod.

The size and proportions of this rod being illustrated in Plate 7, no rule is necessary, as the diameter is rarely altered, the length being the only dimension that is curtailed or increased as the case requires. The handle of the proof rod should not be more than 2 feet 6 inches from the floor line.

Vacuum and Temperature Gauges.

The positions of these gauges are in front. Care should be taken, in centring the holes to receive them, that the centre be equal to 3 or 4 times its diameter from the flange of the arm pipe, the distance of the centre at right angles to the front should be 12 inches, but this, of course, is not imperative; the distance of the end of the temperature rod from the worm should equal 3 to 5 inches.

Steaming Cock.

The diameter of this cock should be 1 inch, secured at one end to the side of the steam supply valve box, and the other to the dome by a flange having a curved pipe on the inside between the worm and the side of the bottom, extending downwards to the third or fourth coil.

Bolts and Nuts.

The depth of the nuts in any case should equal the diameter of the bolt; the shape of the nut in plan should be hexagonal. Size across the angles equals twice the bolt's diameter. The diameter of the bolts for securing the flanges of the vacuum pan should be $\frac{5}{8}$ths to $\frac{7}{8}$ths of an inch; pitch of the bolts $4\frac{1}{2}$ to 5 times that of the diameter. The diameter of the bolts for securing discharge sluice tube $\frac{3}{4}$ths of an inch; the pitch of the bolts $4\frac{1}{4}$ of the diameter. The diameter of the bolts for securing the man hole frame and arm pipe $\frac{3}{4}$ths of an inch; the pitch of the bolts 5 times that of the diameter. The diameter of the bolts for securing the light and sight glass frames, proof rod, and supply steam valve and hand hole door, should be $\frac{1}{2}$ an inch; pitch of the bolts 5 times that of the diameter. The diameter of the bolts for securing the bend pipes $\frac{5}{8}$ths of an inch; pitch of the bolts 4 times that of the diameter. Diameter of the bolts for securing the smaller mountings from $\frac{3}{8}$ths to $\frac{1}{2}$ an inch; pitch 4 times that of the diameter.

Discharge Sluice Gear.

This gear is entirely of wrought iron. The diameter of the lever shaft should be $\frac{1}{4}$th of

the diameter of the valve; the diameter of the bosses of the levers $1\frac{3}{4}$ths of that of the diameter of the hole. Diameter of the connecting rod half the diameter of the lever shaft. Length of the hand lever 15 to 18 inches above the floor line.

Cement.

The cement for making the joints of the different connections should be of the following ingredients:—Litturage, or red lead, 1 part; whitening, or gravel chalk, 2 parts; fine sharp sea sand, 2 parts. The whole well mixed with water and dried on flat open pans, after which put into casks. The mode of using it will be thus:—Mix the above compound with sweet oil to the consistency of putty, then add a portion of spunyarn cut in lengths of about 1 inch; this being well mixed with the cement, will greatly assist its tenacious nature in making a large joint.

Vacuum Pump.

The use of this pump is to exhaust the air and steam from the vacuum pan during the process of boiling. It being essential that the action of exhaustion of air and steam causing thereby a vacuum, should be without the least cessation, two pumps are therefore used. As the surface of the worm is the producer of heated caloric, from it must the cubic contents of the vacuum pump be deduced. Practice teaches that the following rules will be found correct:—The contents of the pump should be from 30 to 40 cubic inches per square foot of heating surface of the worm. The length of the stroke is $1\frac{1}{2}$ to $1\frac{5}{8}$ths of the diameter. Area of the orifice in each valve seating is $\frac{1}{4}$th to $\frac{1}{5}$th of the area of the pump. Thickness of the valves $\frac{1}{8}$th to $\frac{1}{10}$th of its diameter. Thickness of the body $\frac{1}{20}$th of the diameter. Thickness of the lining $\frac{1}{4}$th to $\frac{3}{8}$ths of an inch. Thickness of the metal of the casing for the valves $1\frac{1}{8}$th of that of the body. Depth of the piston $\frac{1}{4}$th to $\frac{1}{5}$th of the diameter. Diameter of the connecting rod pin $\frac{1}{7}$th to $\frac{1}{8}$th of the pump's diameter. The diameter of the trunk of course depends on the length of the connecting rod, for which twice the stroke is a fair length. Diameter of the connecting rod at piston end equals that of the pin, at the crank end $1\frac{1}{4}$th of that of the pin, increased in the centre $\frac{1}{8}$th of an inch per foot in length. Diameter of the pin $\frac{1}{8}$th the diameter of the pump. Pitch of the bolts and nuts 8 times the diameter.

Power.

The mode of ascertaining the power to work the air pumps of a given diameter and length of stroke is thus:—Multiply the area of the air pump by 15 lbs. per square inch, the product multiplied by 100 (speed in feet per minute) equals the total load to be overcome, which, divided by 33,000 (equal to 1 H.P.), the quotient will be the nominal horse-power; to this add 30 per cent. for friction, which will give practically sufficient power to work the two air pumps in a satisfactory manner.

CHAPTER XII.

Heater.

Rule to obtain the shape in section:—The radius for the curve of the bottom should equal $\frac{14}{15}$ths of the diameter. The radii for the curves of the sides should equal $\frac{1}{3}$rd of that of the bottom; this will insure a good shape, so that the heating surface will be in proportion to the steam space. Cubic contents of the heater equal $1\frac{1}{8}$th of the quantity of sugar to be boiled at once. Diameter $1\frac{1}{6}$th of that of the vacuum pan. Depth of copper bottom $\frac{1}{4}$th of the diameter. Space between bottom and casing $\frac{1}{8}$th of the depth of the bottom. Rule to construct the sectional shape of the casing:—Radius of the bottom centrally $\frac{3}{4}$ths of the diameter. Radii of the curves at the side about half that of the bottom. A fixed area of steam supply is not imperative; a good guide is to make it as follows:—1 square inch of area per 12 feet of contents of sugar to be heated at once, this will be a maximum. Diameter of discharge sluice valves 3 to 5 inches. The remaining proportions will be exactly as that of the vacuum pan.

Clarifier.

The cubical contents of these clarifiers are governed by the surface of the sugar-mill roll; the numbers used are not imperative; three constitute a good ratio to one mill, allowing each to clarify from 15 to 20 galls. per square foot of surface of the top roll. Diameter of clarifier equals about $2\frac{3}{4}$ to 3 times the diameter of the roll, being semicircular in shape; the depth equals $\frac{1}{2}$ its diameter, having a light course in height $\frac{1}{4}$ of its diameter. Surface of the worm $\frac{1}{5}$th to $\frac{1}{6}$th of a square foot per gallon of cane-juice. The discharge cock from $1\frac{1}{2}$ to 2 inches diameter. The remaining portion of the pan is the same in proportion as that of the vacuum pan.

Melting Pan.

The diameter of this pan should be equal to that of the vacuum pan; this is not imperative; a few inches more or less, to make an even dimension, will not be detrimental; thickness of the body 1 to $1\frac{1}{4}$ inch; the thickness of the bottom should be $1\frac{1}{8}$th of that of the body, secured to each other by bolts and nuts, the pitch of which should be 8 times the diameter. Total depth of the pan $\frac{1}{2}$ the diameter. The surface of the worm should be equal to 1 square foot per 8 to 10 gallons of melted sugar. Diameter of the worm 4 to 5 inches. Area of the steam-supply cock $\frac{1}{4}$th of the area of the worm. Area of the exhaust-steam cock equals $\frac{1}{4}$th of the area of the supply cock. The remaining details are the same in proportions as those of the vacuum pan.

Receiving Tank.

This tank may be made to suit its destination. A good proportioned tank, in design and construction, is shown in Plate 9, therefore needs no further comment here.

Charcoal Cisterns.

These cisterns are made of wrought iron, with plates $\frac{3}{16}$ths to $\frac{1}{4}$th of an inch thick. The following will enable the proportions to be understood:—The diameter inside at the top should be from 5 to 6 feet, inside diameter at the bottom $\frac{7}{8}$ths of that of the top. Height four times the diameter at the bottom. Space around the body 3 inches. Size of angle iron 3 inches by 3 inches. Size of man hole 14 inches by 18 inches. Diameter of the steam-supply cock $1\frac{1}{4}$ inch. Diameter of the steam-discharge cock $\frac{5}{8}$ths of an inch. Diameter of air-cock $\frac{1}{2}$ an inch. Diameter of the liquor-discharge pipe $1\frac{1}{4}$ inch. Safety valve loaded to a pressure of 1 lb. per square inch.

Bag Filter.

The thickness of the body should be $\frac{3}{8}$ths of an inch. The thickness of the bell-plate $1\frac{1}{4}$ to $1\frac{1}{2}$ inch. The inner diameter of the bells 1 inch. Thickness of the bells $\frac{1}{8}$th of an inch. Length of the bells from 4 to $4\frac{1}{2}$ inches. Diameter of discharge liquor pipe 1 inch. Pitch of the bells from $4\frac{1}{4}$ to $6\frac{1}{4}$ inches, according to the size of the bags used; the length of the bags should not be more than 6 feet. A steam cock $\frac{3}{4}$ths of an inch in diameter, fixed centrally at the back, is sometimes used to prevent congelation of the sugar during the process of filtering through the bags.

Condensing Box.

The size of this box is not imperative, but a good proportion is to make the diameter 1 inch per foot of the diameter of the vacuum and heating pan, and the depth twice the diameter of the box. The thickness of the metal for the body and cover 1 inch. The thickness of the bottom $1\frac{1}{8}$th of that of the body. Diameter of the float $\frac{3}{4}$ of the diameter of the box. Parallel depth of the float $\frac{1}{2}$ the diameter. Thickness of the metal (copper) barely $\frac{1}{16}$th of an inch. Position of the float midway. Area of the discharge valves 4 times the united areas of the steam pipes discharging into the box.

Divisional Sight Tanks.

Length of each division from 4 to 5 feet. Width $\frac{1}{4}$th of the length. Depth $\frac{3}{4}$ths of the width. Thickness of the metal $\frac{3}{4}$ths of an inch for 3 divisions, increasing $\frac{1}{16}$th of an inch for each extra division. Diameter of discharge pipe 1 inch.

Centrifugal Machine.

This machine being generally of one size, the illustration in Plate 11 will clearly enable the reader to understand the proportions; a slight deviation may be made, increasing or diminishing them for a larger or smaller machine.

Scum Press.

This press being generally of a fixed size, and of so simple a character, the illustration in Plate 11 will enable the maker to construct a larger or smaller press in proportion, with the understanding that the deviation must be very slight, on account of the unequal strain the

press is exposed to; also that all metals are less in strength in proportion to their sectional area becoming smaller.

Shaping and Nosing Machine.

The shafts of these machines being the principal part, the proportion should be from $1\frac{1}{2}$ to 2 inches in diameter, when about 2 to 3 feet in length; the cast-iron part $\frac{5}{8}$ths to $\frac{1}{2}$ an inch in thickness; wrought iron $\frac{1}{8}$th of an inch in thickness. The thickness of the brasses $\frac{1}{4}$th of the diameter of the shaft. Length of bearings $1\frac{1}{2}$ the diameter. Diameter of the holding-down bolts $\frac{3}{4}$ of an inch.

Pulling-up Machine.

As these machines are various in design, and at the same time do not come under the head of sugar machinery, a brief notice only will be given. The nominal power is usually from six to eight-horse, and the chains used in hauling from $\frac{1}{2}$ to $\frac{5}{8}$ths of an inch.

Cask Steamer.

The case should be made of wrought iron plates $\frac{3}{16}$ths of an inch in thickness, and of a sufficient diameter and height to enable the casks to be entirely covered by it, the steam descending into the cask, which has a hole bored in its bottom; the melted sugar flows into the receptacle beneath. Thickness of the bottom $\frac{3}{4}$ths of an inch. Thickness of the ribs $\frac{5}{8}$ths of an inch. Four clamp screws 1 inch in diameter. As the casks imported vary in diameter and length, it would be useless to give any decided dimensions for the steaming case, which should be of such a height that the parallel part may equal the length of the cask; the diameter should be sufficiently large to allow a clear space of from 2 or 3 inches around the cask. The supporting brackets are to be of cast iron, secured by bolts and nuts on the outside midway from the top; the thickness $\frac{5}{8}$ths of an inch for the ribs, and $\frac{3}{4}$ths of an inch for the bottom and back; the bolts for securing to the beam 1 inch in diameter. The chain pulleys are of cast iron, 6 to 8 inches in diameter. The diameter of the links of the chain $\frac{1}{2}$ an inch; 2 chains being used, 1 on each side of the bottom. The drum of the chain should be of cast iron $\frac{3}{4}$ths of an inch thick; outside diameter 12 inches. Length 18 inches to 2 feet. Diameter of the shaft $2\frac{1}{2}$ to 3 inches. Radius of the handle 14 inches. Length of the handle 14 inches. Diameter of the handle 1 inch, having a wooden grasping tube 2 inches diameter, with brass bushes at each end to revolve on.

CHAPTER XIII.

Charcoal Burning Furnace Retorts.

Length of the retorts 6 to 8 feet. Outer diameter of the retorts 1 inch per foot in length. Thickness of the metal $\frac{3}{4}$ths to 1 inch. Pitch of the retorts $1\frac{1}{2}$ to 2 of their diameter. Grate surface should equal $\frac{1}{13}$th to $\frac{1}{14}$th of the total heating surface of the retorts. Area of the flue leading to the chimney $\frac{1}{4}$th to $\frac{1}{5}$th that of the grate surface. The width of the furnace

inside equals 3 times the width of the grate. The length of the furnace equals the space occupied by the retorts plus the diameter of 1 retort. The proportions for the remaining parts of the details are so clearly illustrated in Plate 13, and the deviation so slight, either for a larger or smaller furnace, any further description is unnecessary.

Revolving Retorts.

The inner diameter of the retort should be from 3 feet to 3 feet 6 inches. Diameter of the bearing end $\frac{1}{3}$rd of the diameter of the retorts, the bearing part being increased in thickness $\frac{1}{4}$th of an inch. Thickness of the metal 2 to $2\frac{1}{4}$ inches. Length of the bearing $\frac{3}{4}$ths of its diameter. Length of the retort exposed to the fire $2\frac{1}{2}$ to 3 times the diameter. Thickness of the metal of retort $\frac{1}{2}$ of an inch per foot in diameter. Area of the grate surface $\frac{1}{15}$th to $\frac{1}{18}$th of the heating surface of the retorts. Total area of the side flues to each retort 22 to 25 square inches per square foot of grate surface. Diameter of the bearings of the driving shaft $\frac{7}{8}$ths of an inch for each retort, commencing with 3 retorts, 6 being the average number set in one structure. The remaining portions of the details deviate so slightly, that the illustrations in Plate 14 will be the best guide for the maker to complete the manufacture and erection of the entire apparatus.

GENERAL REMARKS.

The rules for the remaining proportions of the machinery used in the production of sugar are of such a simple character, that those given for the designing and construction of the different apparatus already described and illustrated, will produce, to a certain extent, exactitude of the remainder to be obtained. In the designing, or superintending of the design or construction of any machine or machinery, it is highly essential that the manager of any works should be fully qualified by possessing a good sound practical knowledge of mechanics in general, a full knowledge of moulding, casting, forging, pattern making, fitting, turning, boring, and erecting, quick perception, and a just appreciation of those engaged under him; but it is too often the case that the blunders of the managers are attributed to the draughtsmen (this class of men (being essential to carry out work of any note), but where the just appreciation is mutual the blunders are less, and a desire to please each other arises, all parties retiring to their homes with good wishes for each other, ending each business day profitably to all concerned. Whereas, should there be a non-reciprocity of feeling on both sides, how much time is wasted in reprimanding and explanations, producing disgust and carelessness, both of which are detrimental to the interests of the employer and employés.

The next class are the foremen of the moulders, smiths, pattern makers, fitters, turners, and erecters; each foreman should have a correct general knowledge, theoretically, of the particular branch he is deputed to direct, and his practical information should be complete, as far as the present information will allow. The first duties of a foreman should be to impress on all those under him that he can *practically illustrate* the correct workmanlike manner of

performing their respective duties. The mode of directing men causes either great disgust and idleness, or secures their respect and diligence. A competent man will in most instances direct his men in a firm, cheerful tone, at the same time admitting no familiarity, thus enabling the work to proceed as it should do—viz. *a credit to all concerned.*

In the sugar-houses the mode of direction should be in principle the same as that for the manufacturing engineering department, already described. The machinery in sugar-houses requires great attention, on account of the surcharged state of the atmosphere (due to the sugar) pervading the interior of the building. All the working bearings require lubrication without the least intermission; it would also be advisable that all small engines, shafting, pulleys, gearing, &c., should be cased, to prevent the accumulation of dirt. The steam engines must be kept clean, all stuffing boxes properly packed, and the glands screwed down truly, to prevent undue strain. With reference to the boilers, great care and attention should be given to the height of the water, pressure of the steam, &c. The first duty of a stoker, after lighting the fire, should be to open the safety valve, so as to allow the air to escape, closing it only when the steam issues out with a moderate force; this will insure prevention of explosion on first using the steam at its required pressure. Previous to admitting the steam into the engines or casings of any of the apparatus, the air cocks and condense-steam cocks should be fully opened, to insure the exit of air and water. Having described the true principle of the process of producing sugar from the cane, and the manufacture and use of the improved machinery (designed by the author), both theoretically and practically, he concludes with the hope that his efforts will be received with indulgence should he have omitted any part of the entire process which this work is intended to describe.

ESTIMATES.

TANKS.

	£	s.	d.
Actual cost of a cast-iron tank 24 × 12 ft., 3 ft. deep, bottom, sides, ends, and flanges together = 589 square ft. @ 20 lbs. = 5 tons. 5 cwt. 0 qrs. 20 lbs. @ £12	63	2	1¼
Bolts and nuts, 728 lbs. @ 4*d.*	12	2	8
Labour, &c.	20	0	0
Iron cement, 10 cwt. @ 10*s.*	5	0	0
	£100	4	9½

	£	s.	d.
Cost of a cast-iron tank 6 × 3 ft., 3 ft. deep, bottom, side, ends, and flanges = together 89 square ft. @ 20 lbs. per foot = 15 cwt. 3 qrs. 16 lbs. @ 12*s.*	9	10	8½
Bolts and nuts, 65 lbs. @ 4*d.*	1	1	8
Labour, &c.	12	0	0
Iron cement, 1 cwt. @ 10*s.*	0	10	0
	£23	2	4½

	£	s.	d.
Actual cost of a cast-iron tank 18 × 12 ft., 6 ft. deep, surface of bottoms, sides, and ends = 576 square ft. @ 20 lbs. per ft. = 5 tons. 2 cwt. 3 qrs. 12 lbs. @ £8	41	2	10¼
Surfacing flanges for jointing 207 square ft. @ 23 lbs. per ft. = 2 tons 2 cwt. 1 qr. 9lbs. @ £8	17	0	1
Ribs on plates, 1 ton 5 cwt. @ £8.	10	0	0
944 ⅞-inch bolts and nuts @ 4½*d.* per lb.	17	14	0
5 longitudinal and 8 transverse stay bolts	5	2	6
Labour	20	0	0
Iron cement, 14 cwt. @ 8*s.*	5	12	0
7 gross of washers @ 2*s.*	0	14	0
	£117	5	5¼
Weight of water in the above tank 36 tons 3 cwt. 4 lbs. Cubic feet in tank 1,296, contents 8,100 gals. @ 6.25 gal. per foot. Weight of tank 8 tons 10 cwt. 1 qr. 12 lbs.			
The cost of a wooden tank of the above dimensions, including iron work, would be about	£90	0	0

VACUUM PANS.

	£	s.	d.
Actual cost of a 5-ft. 6-in. copper vacuum pan, with cast-iron steam case with 3-in. copper worm pipe and all the requisite fittings, complete, with cast-iron exhausting pipe, receiver and condenser, bolts, nuts, &c., copper dome, 5 ft. 6 in. diameter, 2 ft. 2 in. deep, 3 in. rim = 42 feet superficial @ 20 lbs. per ft. = 7 cwt. 2 qrs. @ 2*s.* 2*d.* per lb.	91	0	0
Carried forward	£91	0	0
Brought forward	£91	0	0
Copper bottom 5 ft. 4½ in. diameter, 20 in. deep, 3½ in. rim = 34 superficial ft. @ 20 lbs. per ft. = 6 cwt. 2 qrs. 8 lbs. @ 2*s.* 2*d.*	73	13	4
For planishing, 1½*d.* per lb. extra	9	10	0
60 ft. of 3-in. copper steam worm pipe and 6 pairs of copper flanges, with bolts, nuts, and stays, 3 cwt. 2 qrs. @ 1*s.* 8*d.*	32	13	4
Cast-iron steam case, 11 cwt. 2 qrs. 24 lbs. @ 11*s.* 6*d.*	6	14	8½
Ditto man hole and cover	5	0	0
Discharging plug and washer	3	10	0
Exhausting pipe, receiver, and condenser, 14 cwt. @ 12*s.* 6*d.*	8	15	0
3-in. steam valve	3	10	0
1½-in. water cock	1	10	0
Wrought-iron lever and guard for plug	2	12	0
2-in. charging cock	2	14	0
2-in. injection cock, dial plate, lever, and rod	4	4	0
½-in. air cock	0	2	6
Barometer, thermometer, brass washer, and plug to ditto	6	5	0
Light and sight glasses, with frames	2	10	0
Proof stick and box	4	0	0
Wrought-iron band for pan, with bolts, nuts, &c.	2	16	0
Brass gauge, with glass tube for receiver	3	8	0
5-in. air valve	4	10	0
4 cast-iron columns	1	5	0
Sundry copper bolts	1	1	0
Copper bolts and nuts for man holes	0	18	0
1-inch steaming out cock	1	0	0
Iron bolts and nuts for condenser, receiver, pipe, and cover	1	7	0
Materials, labour, drilling, and fitting-up pan	124	10	0
Wood curb	2	15	0
Packing case for the above pan, complete	5	10	0
	£407	3	10¼

	£	s.	d.
Actual cost of a 9-ft. copper vacuum pan, 6 ft. 4 in. deep, with 2, 3½-in. worms, wrought-iron steam case, cast-iron man hole, plug, condenser, and receiver, standing on six iron columns attached to wood curb, and all necessary fittings, complete :—			
Wrought-iron steam case, 16 cwt. @ 26*s.*	20	16	0
Cast-iron receiver and condenser, 10 cwt. 2 qrs. @ 14*s.*	7	7	0
Cast-iron man hole and eduction pipe	7	0	0
Cast-iron plug and washer	3	0	0
Wrought-iron lever and fittings	2	0	0
6 cast-iron columns	2	0	0
1 wrought-iron ring	1	10	0
2, 3½-in. steam valves	8	0	0
Carried forward	£51	13	0

	£	s.	d.
Brought forward . .	£51	13	0
1 steaming out cock	1	0	0
1 charging cock	2	5	0
1 injection cock, dial plate, and fittings . . .	4	10	0
3 air cocks	1	0	0
1 condense water cock	1	10	0
Barometer, thermometer, with brass washer and plug	6	5	0
Proof stick, box, and washer	4	10	0
Light and sight glass	2	10	0
2, 3½-in. copper elbows, with flanges . . .	2	6	8
1, 8-in. air valve	8	10	0
Copper dome, 9 ft. diameter, 3 ft. 4 in. deep, 4 in. rim = 100 superficial ft. @ 20 lbs. per ft. = 17 cwt. 3qrs. 13 lbs. @ 2*s* 7½*d*.	262	10	0
Copper bottom, 8 ft. 10 in. diameter, 3 ft. deep = 94 superficial ft. @ 20 lbs. per ft. = 16 cwt. 3 qrs. 4 lbs. @ 2*s*. 7½*d*.	246	15	0
8 coils of 3½ in. copper worm, say 154 feet, 22 pairs of 6½ in. copper flanges, and 110 ½-in. copper bolts and nuts = 10 cwt. 1 qr. 4lbs. @ 1*s*. 8*d*. . .	96	0	0
8 coils of 3½-in. copper worm = 160 feet long, 8 cwt. 2 qrs. 8 lbs.	80	7	6
23 pairs of 6½-in. copper flanges, 115 ½-in. copper bolts and nuts = 3 cwt. @ 1*s*. 8*d*. . . .	28	0	0
Copper stays and supports, with bolts for worm .	7	10	0
Brass gauges, with cock and glass	3	15	0
1 drawing off cock	1	0	0
Wood curb and iron work	4	10	0
Bolts and nuts for pan	4	5	0
Labour and materials	180	14	8
	£1,001	6	10

The above vacuum pan requires a 22 in. pump with 70 gals. of injection water per minute.

Actual cost of an 8-ft. copper vacuum pan, 5 ft. deep, with 2 copper steam worms, wrought-iron steam case, cast-iron man holes, exhausting arm, condenser, and receiver, discharge plug, &c.

	tons.	cwt.	qrs.	£	s.	d.
A copper dome, 8 ft. diameter, 2 ft. 8 in. deep @ 2*s*.	0	14	0			
A copper bottom, 8 ft. diameter, 2 ft. 4 in. deep @ 2*s*. per lb.	0	12	2			
	1	6	2	296	16	0
2 copper worms, 156 ft. of 4-in. pipe = 16 cwt. 2 qrs. 24 lbs. @ 1*s*. per lb.				93	12	0
Men's time planishing dome and bottom @ 1½*d*. per lb.				18	11	0
Ditto making the worm @ 8*d*.				62	8	0
Wrought-iron steam case, 10 cwt. @ 32*s*. . .				16	0	0
Supports, braces, bolts, and nuts, and fixing the 2 worms				10	0	0
Cast-iron man hole, complete				5	0	0
Ditto exhausting arm				4	0	0
Ditto receiver and condensing vessel				15	0	0
Ditto discharging plug				3	10	0
Ditto 6 columns				3	0	0
Brass charging cock				2	10	0
Ditto injection cock, dial plate, and lever . . .				5	10	0
Ditto steaming out cock				1	0	0
Ditto condensing water cock				1	10	0
2 connecting pipes to worms				4	0	0
Brass plug and washer for barometer				0	10	0
Ditto for thermometer				0	12	0
Brass proof rod, complete				4	10	0
Carried forward . .				£547	19	0

	£	s.	d.
Brought forward .	£547	19	0
Ditto air cock	0	3	0
Pair of frames, containing light and sight glasses .	1	12	0
Barometer	2	10	0
Thermometer	2	10	0
Iron tube, tinned, for thermometer. . . .	1	0	0
Copper jet pipe for condenser and injection . .	1	0	0
Caulking ring for pan joint	2	0	0
2, 3-in. steam valve bones and fittings . . .	7	0	0
1, 7-in.	8	0	0
Bar and rod iron for bands, lever guides, bolts, nuts, &c.	2	10	0
Iron cement for joint	1	0	0
Strong wood curb	3	0	0
Sundry materials for pan	1	10	0
Men's time making iron bands, levers, guides, bolts, and nuts, fitting and fixing, and completing the pan for packing	185	0	0
	£766	14	0

HEATERS.

Actual cost of a copper heater 8 ft. diameter, 2 ft. deep, with 4-in. rim :—

	£	s.	d.
Copper bottom, 8 cwt. 2 qrs. @ 1*s*. 11*d*. per lb. .	91	4	8
Sight course, 1 cwt. 2 qrs. @ 1*s*. 4*d*. per lb. .	11	4	0
Cast-iron steam case, 20 cwt. @ 12*s*. per cwt. .	12	0	0
Wrought-iron band	1	10	0
Bolts and nuts	4	10	0
Steam valve	3	6	0
Condense water cock	1	0	0
Air cock	0	2	6
Labour and materials	65	10	0
	£190	7	2

Actual cost of a 7-ft. copper heater, 7 ft. diameter, 2 ft. deep, 4-in. rim :—

	£	s.	d.
Copper bottom, 7 cwt. @ 1*s*. 11*d*. per lb. . .	75	2	8
Cast-iron steam case, 20 cwt. @ 12*s*. per cwt. .	12	0	0
Light course	10	0	0
Wrought-iron band	1	10	0
Steam valve	3	6	0
Bolts and nuts	4	10	0
Condense water cock	1	0	0
Air cock	0	2	6
Labour and materials	65	0	0
	£172	11	2

CLARIFIERS.

Actual cost of 4 copper clarifiers, in cast-iron steam cases, each 46 in. in diameter and 42 in. deep, with wrought-iron pipes, brasses, cocks, &c., complete, each standing on 4 cast-iron columns :—

	£	s.	d.
4 copper light courses, each 20 square ft. at 6 lbs. per ft. = 480 lbs. at 1*s*. 8*d*.	40	0	0
4 copper bottoms, each 22 square feet, 18 lbs. per ft. = 14 cwt. 16 lbs. at 1*s*. 11*d*.	151	16	0
4 cast-iron jackets, 5 cwt. 2 qrs. 14 lbs. = 22 cwt. 2 qrs. @ 14*s*. per cwt.	15	15	0
16 cast-iron columns, 6 cwt. @ 14*s*. . . .	4	4	0
4 three-way brass steam and condense water cocks @ £3 15*s*.	15	0	0
4 air cocks	0	10	0
4 double discharge plug cocks @ £3 . . .	12	0	0
4 large wrought-iron bands	3	0	0
Carried forward . .	£242	5	0

	£	s.	d.
Brought forward	£242	5	0
4 small wrought-iron bands	2	5	0
4 cocks, handles, and rods @ 10*s.*	2	0	0
4 wrought-iron bow rods @ 7*s.*	1	8	0
All the requisite bolts and nuts for pan and pipes	6	5	0
Wrought-iron pipes between cocks and pans, and from thence to boiler, say 25 ft. distant, with 2 brass cocks	15	15	0
16 bolts and nuts for columns, each @ 4*s.*	3	4	0
Red lead, iron cement, &c.	1	0	0
Labour, fitting pans together, drilling, jointing, and fitting bend pipes, &c.	125	0	0
	£399	2	0

PUMPS.

Actual cost of a double acting air pump 22 in. diameter, 2 ft. stroke:—

	£	s.	d.
Cast-iron cylinder, 3 cwt. @ 15*s.*	2	5	0
Top and bottom covers, with piston, 3 cwt. 2 qrs. @ 15*s.*	2	12	6
Piston rod, with keyholes and keys	3	0	0
Boring cylinder and facing ends	5	0	0
Turning and boring piston fittings and bolts, including leather	4	0	0
Making and fitting 4 valves, bolts and nuts	4	10	0
Boring covers, turning, drilling, &c.	3	10	0
Springs, levers, joints, and materials	5	0	0
Fitting together, labour, &c.	23	0	0
Timber and making patterns	40	0	0
	£92	17	6

Actual cost of a set of three-throw brass pumps, 8 in. diameter, 18-in. stroke:—

	£	s.	d.
Cast-iron three-throw crank and clutch	5	0	0
2 side frames, with bolts, nuts, and brasses	17	0	0
3 cast-iron nozzles for top and bottom of pumps, with doors, bolts, and nuts	11	0	0
2 cast-iron beams	0	10	0
1 cast-iron outlet, box, and valve	3	10	0
3, 8-inch brass working barrels	19	5	0
3 brass brackets with copper rod, brass pieces, and wrought-iron guide rods	9	0	0
3 guides, with bolts and brass bushes	1	15	0
3 connecting rods, with pins, bolts, nuts, and brasses	8	0	0
3 brass bottom valves, with bolts, nuts, and fittings	4	0	0
Holding-down bolts and nuts to frame	1	15	0
New patterns for all, complete	67	0	0
Labour and materials fitting up	42	0	0
	£189	15	0

FITTINGS FOR A SUGAR REFINERY.

Actual cost of a sugar refinery for delivering to the heaters about 20 tons per diem:—

	£	s.	d.
3 steam boilers, together about 60 horse power, 15 tons, @ £24 per ton	360	0	0
3 sets of furnace work and fittings to ditto @ £30	90	0	0
Men's time unloading fittings and piping	30	0	0
1, 12-horse power non-condensing steam engine, with 2 air pumps and gear	380	0	0
Men's time fitting and erecting engines and pumps	40	0	0
1, 8-ft. vacuum pan and fittings, with close measure	700	0	0
2, 7-ft. copper heaters, with copper light course and fittings	280	0	0
Men's time for fitting and fixing vacuum pan and heater	25	0	0
Carried forward	£1905	0	0

	£	s.	d.	£	s.	d.
Brought forward				£1905	0	0
3 wrought-iron charcoal filters and fittings, 5 ft. 10 in. diameter, 14 ft. deep, plates $\frac{1}{4}$ in. thick, weight 28 cwt. @ 26*s.*	£36	8	0			
False bottom	4	10	0			
Drawing-off cock	1	10	0			
Cast-iron door and frame	2	0	0			
	£44	8	0	133	4	0
Fixing				6	10	0
2 blow-up cisterns, 7×4 ft., 3 ft. 6 in. deep, $\frac{1}{4}$ in. thick, containing 610$\frac{1}{2}$ gals. = 12 cwt. 2 qrs. @ 26*s.*	£16	5	0			
8 longitudinal and 1 transverse pipe, steam valve, and discharging cock	14	12	0			
Time fitting	2	0	0			
	£32	17	0	65	14	0
Men's time fitting and fixing				3	0	0
3 bag filters and fitting, each £50				150	0	0
Men's time fitting and fixing				4	10	0
2 small charcoal wrought-iron filters for magney at top of house, 3 ft. diameter, 6 ft. 6 in. deep, 3-16ths in. thick, 6 cwt. @ 26*s.*	£7	16	0			
Fittings and floor	4	0	0			
	£11	16	0	23	12	0
Men's time fitting and fixing				3	5	0
2 wrought-iron magney cisterns, 8 × 3 ft. × 2 ft. deep, weight 7 cwt. @ 26*s.*	£9	2	0			
2 cocks @ £1 10*s.*	3	0	0			
	£12	2	0	24	4	0
Men's time fitting and fixing				2	0	0
Cast-iron water tank, 12 ft. square, 3 ft. 6 in. deep, weight 4 tons @ £12				48	0	0
4 cast-iron beams, 1 ton 16 cwt. = 7 tons 4 cwt. @ £13	£93	12	0			
$\frac{3}{4}$-in. iron bolts and nuts, 328 lbs. @ 4*d.*	5	9	4			
Washers	0	10	0			
6 long bolts, stays, and nuts	1	12	0			
Cement	1	10	0	102	13	4
Men's time fitting and fixing				17	0	0
Small wrought-iron water tank for use of refinery = 9 cwt. 2 qrs. @ 26*s.*				12	7	0
Men's time fitting and fixing				1	0	0
2 wrought-iron syrup cisterns, 7×6 ft. × 5 ft. deep, $\frac{1}{4}$ in. thick, 16 cwt. @ 26*s.* = £20 16*s.*				41	12	0
Men's time fitting and fixing				2	0	0
2 wrought-iron receiving cisterns from charcoal filters, 10×4 ft. × 3 ft. deep, containing 735 gals., 13 cwt. 3 qrs. @ 26*s.* = £17 17*s.* 6*d.* each				35	15	0
Men's time fitting and fixing				2	0	0
Pulling-up machine and driving gear				165	0	0
Men's time fitting and fixing				12	0	0
40 steam pipes, 5 in. diameter, each 16 ft. long, with 39 double elbows and 6 bearers, 8 tons 8 cwt. 3 qrs.	£118	2	6			
5-in. steam valve	3	10	0			
Condense water cock	0	15	0	122	7	6
Men's time jointing pipes				18	0	0

	ft.	in.		tons.	cwt.	qrs.		£	s.	d.
1st floor	16	6	socket pipes and 3 elbows	0	45	0				
2nd "	16	5	" "	0	39	0				
3rd "	16	5	" "	0	39	0				
4th "	16	5	" "	0	39	0				
5th "	16	4	" "	0	29	0				
6th "	16	4	" "	0	29	0				
7th "	16	4	" "	0	22	2				
				12	2	2	@ £14	169	15	0
Carried forward								£3070	8	10

	£	s.	d.
Brought forward .	£3070	8	10
7 steam valves @ £2 5s.	15	15	0
7 condense water cocks @ 10s.	3	10	0
7 air cocks at 2s.	0	14	0
Bolts and nuts, and wrought-iron hangers . .	8	14	0
Men's time fitting and fixing	40	0	0
Steam main 4 in. pipe, 63 ft.			
Condense water main 5 in. pipe, 63 ft. . .			
Water main 2-in. gas pipe, 100 ft., 6 elbows . .			
Magney main 2-in. pipe, 60 ft., 2 elbows . .	60	17	6
Syrup main 4-in. pipe, 80 ft., 2 elbows . . .			
Condense water main, leading from steam, 2-in. pipe, 20 ft., 2 elbows			
Cement	4	0	0
Connecting pipes and cocks to the syrup cistern, 50 ft. 2 in., copper pipe 4; 2-in. brass cocks, bolts, nuts, and spanners, men's time fixing and jointing	32	0	0
Steam, air, and water connecting pipes to vacuum pan:—			
Steam, 60 ft. = to 36 cwt.; air, 60 ft. = to 19 cwt.; water, 10 cwt. 2 qrs.; total, 3 tons 5 cwt. 2 qrs. @ £14	45	17	0
Steam pipes to heater, 9 cwt. @ 14s.; 2 condense water pipes to and from, 20 ft. @ 2s., and 2 elbows, 2 condense water boxes, each £4 . .	18	12	0
Men's time fixing and jointing	35	0	0
Steam pipes and feed pipes from engine to boiler:—			
Steam, 30 cwt. @ 14s.			
Feed, 70 cwt. @ 2s.	28	6	0
2 elbows @ 3s.			
Men's time fitting and fixing	9	0	0
Add for various pipes and elbows, 3 tons @ £14 .	42	0	0
Sheet lead, red and white lead, millboard, cement, &c.	15	0	0
Carried forward .	£3429	14	4

	£	s.	d.
Brought forward .	£3429	14	4
Patterns, various (extras)	115	0	0
Sundries	300	0	0
Add for wear and tear, labour, &c.	360	0	0
	£4204	14	4

BOILERS.

	£	s.	d.
Actual cost of a boiler 16 ft. 6 in. long, 5 ft. 6 in. diameter, plates 3-8ths thick, weight 2¼ tons @ £23 .	67	10	0
Boiler fittings, complete, and the firework . .	35	0	0
	£102	10	0
3 boilers, high pressure, total 8 tons 10 cwt. @ £20	170	0	0
Total fittings, complete	106	0	0
	£276	0	0
24 horse power high pressure boiler, cylindrical = 4 tons @ £23	92	0	0
Fireplace and fittings	35	0	0
	£127	0	0

SUNDRIES.

	£	s.	d.
14 horse power high pressure steam engine, with 2 air pumps, 18 in. diameter, 2 ft. stroke . .	440	0	0
6 revolving retorts, with their appendages, @ £100	600	0	0
10 vertical stationary charcoal retorts and their appendages @ £10	100	0	0
Sugar mill, complete:—			
Rolls, 2 ft. diameter. 4 ft. in length, @ £400 .	800	0	0
Engine for making the same	250	0	0

INDEX TO PLATES.

SUGAR-CANE CRUSHING MILL. Plate 1.

Reference.

Fig. 1. End elevation, showing cane-juice tank and pump in section
" 2. Side elevation one half section through centre line, one-half complete
" 3. Plan one-half section through centre line of side rolls, one-half complete, with the exception of the top roll pinion, which is in section through centre line

A Side frame
B Top roll
C Bottom roll
D Side frame cap
E Distance piece
F Bed plate
G Feed table support
H Discharge table support
I Cane-guide
J Cane-juice discharge pipe
K " tank
L " pump
M Valve box, connecting pipe, and draw-off cock
N Plunger
O Connecting rod
P Crank and pinion
Q Spur wheel
R Top and side roll shaft
S Rolls spur pinion
T Side roll adjusting bolts
U Holding-down bolts
V Cap bolts
W Lubricator for top roll shaft
X Cane-guide adjusting bolts and nuts
Y Timber top frame
Z Stop plate beams
a Timber work to receive cane-juice tank
b Crough, or stop plate holes
c Masonry

SUGAR MILL—CAST-IRON DETAILS. Plate 2.

Reference.

A	Side frame . . .	Side elevation half complete, half in section through centre line
A^1	. . . . .	End elevation half complete, half in section through centre line
A^2	. . . . .	Plan half complete, half in section through *a b*
B	Top roll . . .	Plan half complete, half in section through centre line
B^1	. . . . .	End elevation complete

SUGAR-MILL.—CAST-IRON DETAILS.

Plate 2. (*Continued.*)

Reference.

C	Bottom roll . . .	Plan half complete, half in section through centre line
C^1	. . . . .	End elevation complete
D	Side frame cap . .	Side elevation complete
D^1	. . . . .	Inverted plan complete
D^2	. . . . .	End elevation complete
E	Distance piece . .	Side elevation half complete, half in section through centre line
E^1	. . . . .	End elevation complete
F	Bed plate . . .	Side elevation complete
F^1	. . . . .	Plan complete
F^2	. . . . .	End elevation half complete, half in section through centre line
G	Feed table support .	Side elevation complete
G^1	. . . . .	Plan complete
H	Discharge table support	Side elevation complete
H^1	. . . . .	Plan complete
I	Cane guide . . .	Plan complete
I^1	. . . . .	Side elevation complete
I^2	. . . . .	Transverse section through centre line
J	Cane-juice tank . .	Plan complete
J^1	. . . . .	Longitudinal sectional elevation through centre line
J^2	. . . . .	End elevation complete
K	Top roll spur pinion .	Plan complete
K^1	. . . . .	Sectional elevation through centre line
L	Bottom roll spur pinion	Plan complete
L^1	. . . . .	Sectional elevation through centre line
M	Cane-juice discharge pipe	Plan complete
M^1	. . . . .	Longitudinal sectional elevation through centre line
N	Holding-down stop plates	Side elevation complete
N^1	. . . . .	Plan complete
O	Discharge pump . .	Front elevation
O^1	. . . . .	Longitudinal sectional elevation
O^2	. . . . .	Sectional plan through *a b*
O^3	. . . . .	Plan of glands
P	Spur wheel for pump .	Side elevation complete
P^1	. . . . .	Sectional elevation through centre line
Q	Cane-juice discharge pump connecting pipe	Longitudinal sectional elevation
Q^1	. . . . .	End elevation complete

BRASS DETAILS. Plate 3.

Reference.

A	Cane-juice and valves discharge pump . .	Front elevation
A^1	. . . . .	Longitudinal sectional elevation through centre line
A^2	. . . . .	Plan half complete through centre line
B	Pump bush . .	Sectional elevation through centre line
B^1	. . . . .	End elevation complete
C	Plunger . . .	Sectional elevation through centre line.
C^1	. . . . .	End elevation complete
D	Gland bush . .	Sectional elevation through centre line
D^1	. . . . .	End elevation complete
E	Bottom roll brass and lubricator . . .	Plan complete
E^1	. . . . .	Sectional elevation of brass
E^2	. . . . .	Side elevation of brass
F	Top roll brass . .	Plan complete
F^1	. . . . .	End elevation complete
G	Connecting rod brass .	Plan complete
G^1	. . . . .	Side elevation complete
H	Adjusting screw nut .	Plan complete
H^1	. . . . .	Sectional elevation through centre line
I	Lubricator . . .	Plan complete
I^1	. . . . .	Sectional elevation through centre line
J	Oil tube . . .	Sectional elevation through centre line
J^1	. . . . .	End elevation complete

WROUGHT-IRON DETAILS. Plate 3.

K	Top roll shaft . .	Side elevation complete
K^1	. . . . .	End elevation complete
L	Discharge pump, crank, and pinion . .	Side elevation complete
L^1	. . . . .	End elevation complete
M	Distance piece tie rod .	Side elevation complete
M^1	. . . . .	End elevation complete
N	Bottom roll shaft . .	Side elevation complete
N^1	. . . . .	End elevation complete
O	Pump connecting rod .	Front elevation complete
O^1	. . . . .	Side elevation complete
O^2	. . . . .	End elevation of top end
O^3	Crank stud and key .	Side elevation complete
O^4	. . . . .	End elevation complete
P	Top roll shaft bolts and nuts	Side elevation complete
P^1	. . . . .	Plan complete
Q	Adjusting bolt screws for bottom rolls . .	Side elevation complete
Q^1	. . . . .	Plan complete
R	Bed-plate holding-down bolts and nuts .	Front elevation
R^1	. . . . .	Side elevation and key in section
S	Cane-guide adjusting bolts and nuts . .	Side elevation
S^1	. . . . .	Plan of nut, the bolt in section
T	Bottom roll brass stay plate . . .	Plan complete
T^1	. . . . .	Sectional elevation through centre line
U	Cap bolt nut stop ring .	Plan complete
U^1	. . . . .	Side elevation complete
V	Adjusting bolt stop ring	Plan complete
V^1	. . . . .	End elevation complete

WROUGHT-IRON DETAILS.—Plate 3. (*Continued.*)

W	Spur pinion keys . .	Plan complete
W^1	. . . . .	Elevation complete
W^2	. . . . .	End elevation complete
X	Cap bolt keys . .	Plan complete
X^1	. . . . .	Side elevation complete
X^2	. . . . .	End elevation complete
Y	Distance piece bolt key	Plan complete
Y^1	. . . . .	Side elevation complete
Y^2	. . . . .	End elevation complete
Z	Top and side roll keys .	Plan complete
Z^1	. . . . .	Side elevation complete
Z^2	. . . . .	End elevation complete
Z^3	Feed table . . .	End elevation complete
Z^4	Discharge table . .	End elevation complete
a	Bolts and nuts for table and supports . .	Side elevation complete
b	Connecting rod, cap bolts, and nuts .	Side elevation complete
c	Eye stud for connecting	Side elevation
c^1	. . . . .	End elevation complete
d	Connecting rod cap .	Plan complete
d^1	. . . . .	Side elevation complete
e	Tank holding-down bolts and nuts . . .	Side elevation complete
f	Tank holding-down bolts, stop plates . .	Plan complete
f^1	. . . . .	Side elevation complete
g	Side frame adjusting key	Plan complete
g^1	. . . . .	End elevation complete
h	Table support adjusting key	Plan complete
h^1	. . . . .	End elevation complete
i	Cane-juice discharge pump valve stops .	Side elevation
i^1	. . . . .	Plan complete
j	Discharge pipe bolts and nuts . . .	Side elevation
k	Stud for valve-box door	Side elevation
l	Brass tank flange bolts and nuts . . .	Side elevation
m	Discharge pipe from tank to pump . .	Side elevation
n	Pump gland studs and nuts . . .	Side elevation
o	Table studs . . .	Side elevation
o^1	. . . . .	Plan

VACUUM PAN AND CONNECTIONS. Plate 4.

Reference.

Fig. 1. Longitudinal sectional elevation complete
" 2. Front elevation complete
" 3. Plan complete

Letters.	Names.	Materials.
A	Dome	Copper
B	Bottom . . .	Copper
C	Casing . . .	Cast iron
D	Worm and stays . .	Copper
E	Sluice or discharge valve	Gun metal
F	Hand hole door . .	Cast iron
G	Charging cocks . .	Gun metal
H	Measure . . .	Copper
I	Air cock . . .	Gun metal
J	Measure covers and frame	Gun metal
K	Vacuum cock and pipe .	Gun metal and copper
L	Man hole frame and covers . . .	Gun metal
M	Arm pipe . . .	Copper
N	Vacuum gauge . .	Gun metal, glass tube

VACUUM PAN AND CONNECTIONS.

PLATE 4. (*Continued.*)

Reference.

Letters.	Names.	Materials.
O	Temperature gauge	Gun metal, glass tube
P	Air cock	Gun metal
Q	Sight glass	Gun metal, glass disc
R	Light glass	Gun metal, glass disc
S	Proof rod and casing	Gun metal
T	Steam valve for worm	Gun metal
U	Steaming out cock	Gun metal
V	Liquor waste cock	Gun metal
W	Receiver	Cast iron
X	Condenser	Cast iron
Y	Injection cock and pipe	Gun metal and copper
Z	Stop valve and seat	Gun metal
a	Measure liquor gauge	Gun metal and glass
b	Receiver liquor gauge	Gun metal and glass
c	Air cock	Gun metal
d	Stop valve handle and index	Gun metal and wrought iron
e	Receiver cleansing cock	Gun metal
f	Steam casing air cock	Gun metal
g	Safety valve	Gun metal
h	Guide for lever	Wrought iron
i	Discharge valve lever	Wrought iron
j	Sluice valve connecting rod	Wrought iron
k	Waste steam cock handle	Wrought iron
l	Waste steam cock	Gun metal
m	Bend pipe	Gun metal
n	Main waste pipe	Cast iron
o	Main holding bolts	Wrought iron
p	Support brackets	Cast iron
q	Band	Wrought iron
r	Measure column	Cast iron
s	Receiver column	Cast iron
t	Vacuum connecting pipe	Copper

COPPER DETAILS. PLATE 5.

Reference.

Fig. 1. Longitudinal section, showing mode of brazing connection of worm
" 2. Part elevation of worm stay
" 3. Transverse section of copper bottom, worm, and stay, also showing mode of supporting worm

Letters.	Names.	Materials.
A	Worm stay	Copper
B	Worm	Copper
C	Supports	Copper
D	Bolts and nuts	Gun metal
E	Bottom	Copper

SLUICE DISCHARGE VALVE. PLATE 6.

Reference.

Fig. 1. Longitudinal sectional elevation showing connection of valve bottom and casing
" 2. Is an elevation of frame, half in section, half complete
" 3. Plan of valve and frame, half in section, half complete
" 4. Plan showing number of bolts required to secure the tube to the bottom

Letters.	Names.	Materials.
A	Tube	Gun metal
B	Bottom	Copper

SLUICE DISCHARGE VALVE. PLATE 6. (*Continued.*)

Reference.

Letters.	Names.	Materials.
C	Casing	Cast iron
D	Washer	Gun metal
E	Screw frame	Gun metal
F	Valve	Gun metal
G	Connecting frame	Gun metal
H	Valve guides	Gun metal
I	Frame studs and nuts	Gun metal
J	Tube bolts and nuts	Gun metal

CONNECTION OF FLANGES. PLATE 6.

Reference.

Fig. 5. Section of wrought-iron band, copper dome and band, cast-iron casing and wrought-iron washer, the wrought-iron bolt being complete
" 6. Is the plan of the head of the bolt, the stop of bolt being seen in dotted lines

A	Recess to receive the cement to make the joint	In cast-iron flange

PROOF ROD. PLATE 7.

Reference.

Fig. 1. Longitudinal sectional elevation of proof rod casing, the rod being in section at one end only
" 2. Transverse sectional elevation through *a b*
" 3. Elevation of stop nut through *c d*, the rod being in section
" 4. Transverse section through *e f*
" 5. Transverse section through *g h*
" 6. End elevation of tube casing

Letters.	Names.	Materials.
A	Flange casing	Gun metal
B	Stop nut	Gun metal
C	Proof rod	Gun metal
D	Stop plug	Gun metal
E	Stop plug casing	Gun metal
F	Proof rod casing	Gun metal
G	Stop plug nut	Gun metal

LIGHT GLASS. PLATE 7.

Reference.

Fig. 7. Plan complete
" 8. Longitudinal sectional elevation through centre line

Letters.	Names.	Materials.
A	Glass	Glass
B	Frame complete	Gun metal
C	Part of dome	Copper

SIGHT GLASS. PLATE 7.

Reference.

Fig. 9. Plan complete
" 10. Longitudinal sectional elevation through centre line

Letters.	Names.	Materials.
A	Glass	Glass
B	Frame complete	Gun metal
C	Part of dome	Copper

POSITION OF PROOF ROD. PLATE 7.

Reference.

Fig. 11. This figure shows a part of the dome and bottom in section, the worm is represented in section by the circles, equidistant from each other, the centre line being drawn through each and continued to that of the vacuum pan, intersects; it will be by this understood that the centre line of the proof rod, commencing from the proposed position on the dome and continued to that of the intersection already described, will be the proper angle

Letters.	Names.	Materials.
A	Section of dome . .	Copper
B	Section of bottom .	Copper
C	Proof rod and casing complete	Gun metal
D	Proof rod casing support. . . .	Gun metal
E	Section of worm . .	Copper

VACUUM PUMP. PLATE 8.

Reference.

Fig. 1. Longitudinal sectional elevation through centre line
" 2. Sectional plan through centre line
" 3. Back end elevation of valves door, discharge and suction pipes
" 4. Front elevation of cover and brackets

Letters.	Names.	Materials.
A	Body	Cast iron
B	Cover	Cast iron
C	Valve box . . .	Cast iron
D	Lining. . . .	Gun metal
E	Brackets (supporting) .	Cast iron
F	Brackets (connecting) .	Cast iron
G	Gland	Gun metal
H	Trunk	Gun metal
I	Connecting rod eye bolt	Wrought iron
J	Piston	Gun metal
K	Valve seat . . .	Gun metal
L	Valves	India-rubber
M	Valve seat bolts . .	Gun metal
N	Guard bolt . . .	Gun metal
O	Valve guard . . .	Gun metal
P	Valve box doors . .	Cast iron
Q	Exhaust passage . .	Cast iron
R	Suction passage . .	Cast iron

HEATING PAN. PLATE 9.

Reference.

Fig. 1. Plan complete
" 2. Longitudinal sectional elevation

Letters.	Names.	Materials.
A	Bottom	Copper
B	Casing	Cast iron
C	Band	Wrought iron
D	Air cock . . .	Gun metal
E	Steam supply cock .	Gun metal
F	Discharge sluice valve and tube . . .	Gun metal
G	Lever connecting rod .	Wrought iron
H	Lever handle . .	Wrought iron
I	Steam cock discharge .	Gun metal
J	Safety valve . .	Gun metal
K	Holding-down bolts and nuts. . . .	Wrought iron

CLARIFYING PAN. PLATE 9.

Reference.

Fig. 3. Plan complete, with the exception that the worm is omitted, centre line being only shown
" 4. Is a longitudinal sectional elevation

Letters.	Names.	Materials.
A	Bottom . . .	Copper
B	Casing. . . .	Cast iron
C	Worm	Copper
D	Light course . .	Copper
E	Steam-cock supply .	Gun metal
F	Liquor discharge cock and tube . . .	Gun metal
G	Strainer . . .	Gun metal
H	Bottom bend pipe .	Gun metal
I	Hand-hole door . .	Cast iron
J	Steam-cock discharge .	Gun metal
K	Air cock . . .	Gun metal
L	Band	Wrought iron
M	Safety valve . . .	Gun metal
N	Worms stays . .	Copper
O	Top bend pipe . .	Gun metal
P	Column brackets . .	Cast iron

MELTING PAN. PLATE 9.

Reference.

Fig. 5. Plan complete, with strainer removed, partly in section through *a b*
" 6. Segment of strainer plan complete
" 7. Longitudinal sectional elevation complete

Letters.	Names.	Materials.
A	Body	Cast iron
B	Strainer . . .	Gun metal
C	Worm . . .	Copper
D	Bend pipe . . .	Gun metal
E	Bottom . . .	Cast iron
F	Supply steam cock .	Gun metal
G	Handle and rod for ditto	Wrought iron
H	Supply steam pipe .	Wrought iron
I	Liquor discharge cock .	Gun metal
J	Worm stays . .	Copper
K	Air cock . . .	Gun metal
L	Discharge steam cock .	Gun metal
M	Safety valve . .	Gun metal
N	Holding-down bosses .	Cast iron

RECEIVING TANK. PLATE 9.

Reference.

Fig. 8. Sectional plan through *a b*
" 9 Side elevation complete

Letters.	Names.	Materials.
A	Discharge hole . .	Cast iron
B	Flanges . . .	Cast iron
C	Body	Cast iron

CHARCOAL CISTERN. PLATE 10.

Reference.

Fig. 1. Sectional elevation through centre line
" 2. Plan showing strainers removed
" 3. Segment of top strainer
" 4. Sectional plan through man hole with strainer removed
" 5. Segment of bottom strainer
" 6. Plan of man hole frame and door

CHARCOAL CISTERN. Plate 10. (*Continued.*)

Reference.

Letters.	Names.	Materials.
A	Body	Wrought iron
B	Casing . . .	Wrought iron
C	Bottom . . .	Wrought iron
D	Top strainer . .	Cast iron
E	Bottom strainer . .	Cast iron
F	Man-hole door and frame	Cast iron
G	Bottom strainer stay .	Wrought iron
H	Top air cock and bush .	Gun metal
I	Safety valve . .	Gun metal
J	Steam discharge bush .	Wrought iron
K	Steam supply cock .	Gun metal
L	Bottom air cock . .	Gun metal
M	Discharge steam cock .	Gun metal
N	Internal angle irons .	Wrought iron

BAG FILTER. Plate 10.

Reference.

Fig. 7. Sectional plan, one half showing strainer, one half showing bell plate
" 8. Front elevation, one half being in section

Letters.	Names.	Materials.
A	Body	Wrought iron
B	Bottom . . .	Wrought iron
C	Strainer . . .	Gun metal
D	Bell plate . . .	Gun metal
E	Bells	Gun metal
F	Doors and hinges . .	Cast iron
G	Door stops . . .	Wrought iron
H	Liquor discharge bushes	Gun metal

CONDENSING BOX. Plate 10.

Reference.

Fig. 9. Sectional elevation through centre line
" 10. Plan, one half complete, one half in section

Letters.	Names.	Materials.
A	Body	Cast iron
B	Cover	Cast iron
C	Bottom . . .	Cast iron
D	Float	Copper
E	Valve rod guide . .	Gun metal
F	Valve seating and rod .	Gun metal
G	Provision for discharge steam pipe . .	Cast iron
H	Ditto for water when requisite . . .	Cast iron

DIVISIONAL SIGHT TANK. Plate 10.

Reference.

Fig. 11. Transverse sectional elevation
" 12. Longitudinal sectional elevation
" 13. Plan complete

Letters.	Names.	Materials.
A	Liquor discharge bushes	Gun metal
B	Body	Cast iron

CENTRIFUGAL MACHINE. Plate 11.

Reference.

Fig. 1. Sectional plan, half through C^1 D, half through C^2 D^1
" 2. Longitudinal sectional elevation through centre line
" 3. Plan complete, part broken to show connection of brake guide bracket
" 4. Front elevation complete

Letters.	Names.	Materials.
A	Body	Cast iron
B	Centre supporting piece	Cast iron
C	Connecting bolts . .	Wrought iron
D	Vertical shaft . .	Wrought iron
E	Basket cone . .	Cast iron
F	Bell	Gun metal
G	Nut	Gun metal
H	Basket frame . .	Wrought iron (galvanized)
I	Cone stop nut . .	Cast iron
J	Cone bush . . .	Gun metal
K	Steam spray pipe .	Wrought iron
L	Lubricator . . .	Gun metal
M	Pulley . . .	Cast iron
N	Toe bush . . .	Gun metal
O	Toe plate . . .	Steel
P	Toe bush casing . .	Cast iron
Q	Adjusting bolt and nut for vertical shaft .	Wrought iron
R	Brake handle guide bracket . . .	Cast iron
S	Eye bracket for lever handle . . .	Wrought iron
T	Thrust rod . . .	Wrought iron
U	Lever handle . .	Wrought iron
V	Lubricator and tube for toe end of vertical shaft	Gun metal
W	Brake	Ash
X	Brake spring . .	Wrought iron
Y	Lubricating pipe . .	Wrought iron

Fig. 5. Section of basket, half size
" 6. Portion of strainer
" 7. Thickness of ditto; these two last are full size

SCUM PRESS. Plate 11.

Reference.

Fig. 8. Longitudinal sectional elevation
" 9. Plan complete

Letters.	Names.	Materials.
A	Body	Cast iron
B	Screw	Wrought iron
C	Piston . . .	Cast iron
D	Cross head . . .	Wrought iron
E	Cross head stay rods .	Wrought iron
F	Nut	Gun metal
G	Ratchet lever . .	Wrought iron
H	Ratchet wheel . .	Wrought iron
I	Strainer . . .	Cast iron
J	Receiver . . .	Cast iron
K	Discharge pipe . .	Cast iron
L	Holding-down bolts .	Wrought iron
M	Foundation . . .	Granite

EXPANSION VALVE. Plate 12.

Reference.

Fig. 1. Longitudinal sectional elevation through centre line
" 2. Transverse sectional elevation
" 3. Sectional plan through letter *a*
" 4. Plan complete

EXPANSION VALVE. Plate 12. (*Continued.*)

Reference.

Letters.	Names.	Materials.
A	Body	Gun metal
B	Cover	Gun metal
C	Equilibrium valve	Gun metal
D	Spring piston . .	Gun metal
E	Adjusting guide plate .	Gun metal
F	Connecting rods . .	Copper
G	Stay rods . . .	Wrought iron
H	Spring	Steel
I	Cover bolts and nuts .	Wrought iron
J	Guide rod and nut .	Gun metal
a	High pressure steam supply passage .	Gun metal
b	Low pressure steam discharge passage .	Gun metal
c	Connecting passage	

CHARCOAL BURNING FURNACE. Plate 13.

Reference.

Fig. 1. Sectional plan through the opening to receive the fuel and the flue of chimney
" 2. A transverse sectional elevation
" 3. Plan complete
" 4. Longitudinal sectional elevation

Letters.	Names.	Materials.
A	Retort . . .	Cast iron
B	Feed plate . . .	Cast iron
C	Retort support plate .	Cast iron
D	Brickwork support plate	Cast iron
E	Charcoal stop plate and handle . . .	Wrought iron
F	Dead plate and frame .	Cast iron
G	Fire bars . . .	Cast iron
H	Bearing bars . .	Cast iron
I	Ashes box . . .	Cast iron
J	Damper chain . .	Wrought iron
K	Damper and frame .	Cast iron
L	Bracket and pulley .	Cast iron
M	Damper balance . .	Cast iron
N	Vertical stay girders, tie rods, and nuts	Cast iron
O	Fire bridge . . .	Fire brick
P	Fireplace . . .	Fire brick
Q	Flue to chimney . .	Fire brick
R	Chimney . . .	Brickwork
S	Lining . . .	Fire brick
T	Structure . . .	Common brick
U	Gas tube . . .	Wrought iron

WROUGHT-IRON DETAILS. Plate 13.

Reference.

Letters.	Names.	Materials.
a	Stop plate and handle .	Plan
*a*¹	. . . . . .	Elevation

CAST-IRON DETAILS. Plate 13.

Reference.

b	Retort	Longitudinal sectional elevation
*b*¹	. . . . . .	Sectional plan
c	Feed plate . . .	Plan
*c*¹	. . . . . .	Transverse section
*c*²	. . . . . .	Side elevation
d	Brickwork support plate	Side elevation
*d*¹	. . . . . .	Transverse section
e	Retort support plate .	Plan
*e*¹	. . . . . .	Transverse section
*e*²	. . . . .	Side elevation

REVOLVING RETORTS. Plate 14.

Reference.

Fig. 1. Longitudinal sectional elevation
" 2. Front elevation of two retorts complete, the remaining one being in section
" 3. Plan half in section through centre line, the other half complete
" 4. Back end elevation

A	Structure . . .	Common brick
A¹	Lining . . .	Fire brick
A²	Side flues . . .	Fire brick
A³	Main flue . . .	Fire brick
A⁴	Discharge gas box .	Brickwork
B	Retort	Cast iron
C	Front end . . .	Cast iron
D	Back end . . .	Cast iron
E	Supporting brackets .	Cast iron
F	Supporting girder . .	Cast iron
G	Supporting columns .	Cast iron
H	Worm and sliding clutch	Cast iron
I	Worm wheel . .	Cast iron
J	Discharge gas pipe .	Cast iron
K	Gas box cover . .	Cast iron
L	Worm shaft supporting bracket . . .	Cast iron
M	Worm shaft . . .	Cast iron
N	Clutch gear . . .	Wrought iron
O	Front and back plates .	Cast iron
P	Vertical stay girder .	Cast iron
Q	Tie rods, bolts, and nuts	Wrought iron
R	Damper gear . .	Wrought iron
S	Damper and frame .	Cast iron
T	Foundation for column .	Granite
U	Ashes box . . .	Cast iron
V	Fire door . . .	Cast iron
W	Fire bars . . .	Cast iron
X	Bearing bar . . .	Cast iron
Y	Fire door, frame, and dead plate . .	Cast iron
a	Shifting discharge door	Wrought iron
b	Sight stop . . .	Wrought iron
c	Shifting door stops .	Wrought iron
d	Stop plates . . .	Wrought iron
e	Girders distance stays .	Wrought iron
f	Girder securing bolts .	Wrought iron
g	Bracket brasses . .	Gun metal
h	Discharge gas pipe gland	Cast iron
i	Column securing bolt keys . . .	Wrought iron

COLONIAL FACTORY. Plate 15.

Reference.

This Plate represents a Colonial Factory for producing moist and loaf-sugar from the sugar-cane.

Fig. 1. Plan showing the building in section
" 2. Longitudinal sectional elevation through G H.
" 3. Transverse sectional elevation through E F, showing vacuum pans and heater
" 4. Transverse sectional elevation through C D, showing sugar-mill, engines, gearing, and the foundations
" 5. Transverse sectional elevation through A B, showing 3 steam boilers, one half of which is in section, in order to show the mode of setting

A Boiler house
B Stoke hole
C Carpenters' shop
D Smiths' shop
E Megas drying room
F Cane-mill room
G Clarifying room

SUGAR REFINERY (HOME). PLATE 16. (*Continued.*)

Reference.

G Vacuum pan or boiling room
H Heating and pump room
I Filling, draining, and curing room
J Bastard draining room
K Lump draining room
L Filter draining room
M Loaves draining room, also where the sugar is prepared to enter the stoves
N Stove
P Coal store
Q Boiler house
R Stack or chimney
No. 1. 1 water tank, 26 ft. square, 6 ft. 6 in. deep
" 2. Main water pipe, 3 in. diameter
" 3. 3 bins, 9 ft. square, 4 ft. deep
" 4. Steam crane, 8 HP.
" 5. 1 engine, 8 HP.
" 6. 3 melting pans, diameter 8 ft., depth 3 ft.
" 7. Shafting and gear
" 8. Liquor cocks
" 9. Water cocks
" 10. Waste water cock
" 11. 9 bag filters, width 6 ft. by 3 ft., 8 ft. 6 in. deep
" 12. 6 sight tanks, length 8 ft. 3 in., width 2 ft. 6 in., depth 1 ft. 6 in.
" 13. Liquor cocks
" 14. Waste water

SUGAR REFINERY (HOME). PLATE 16. (*Continued.*)

Reference.

No. 15. 6 charcoal cisterns, depth 21 ft., mesne diameter 5 ft. 6 in.
" 16. 6 divisional sight tanks
" 17. 3 receiving cisterns, 11 ft. 6 in. square, depth 5 ft.
" 18. Liquor cocks and pipes to the vacuum pan
" 19. Main stamp pipe
" 20. 3 boilers, diameter 7 ft., length 30 ft.
" 21. Feed water pipe
" 22. 1 donkey engine, 3 HP.
" 23. 6 centrifugal machines, 3 ft. 3 in. diameter
" 24. 6 engines, each of 2½ HP.
" 25. Troughs
" 26. 2 heaters, diameter 9 ft.
" 27. Expansion valves
" 28. 2 sets of vacuum pumps and engines, engine 14 HP. each pump, diameter 18 in., stroke 2 ft.
" 29. Suction pipe
" 30. Discharge pipe
" 31. 2 vacuum pans, diameter 7 ft. 6 in.
" 32. 3 throw pumps and engine, 6 HP.
" 33. Nosing machine
" 34. 1 shaping machine
" 35. 1 crushing machine
" 36. 1 engine, 6 HP.
" 37. Steam lift
" 38. Steam worm for stove
" 39. Damper gear

DESCRIPTION.

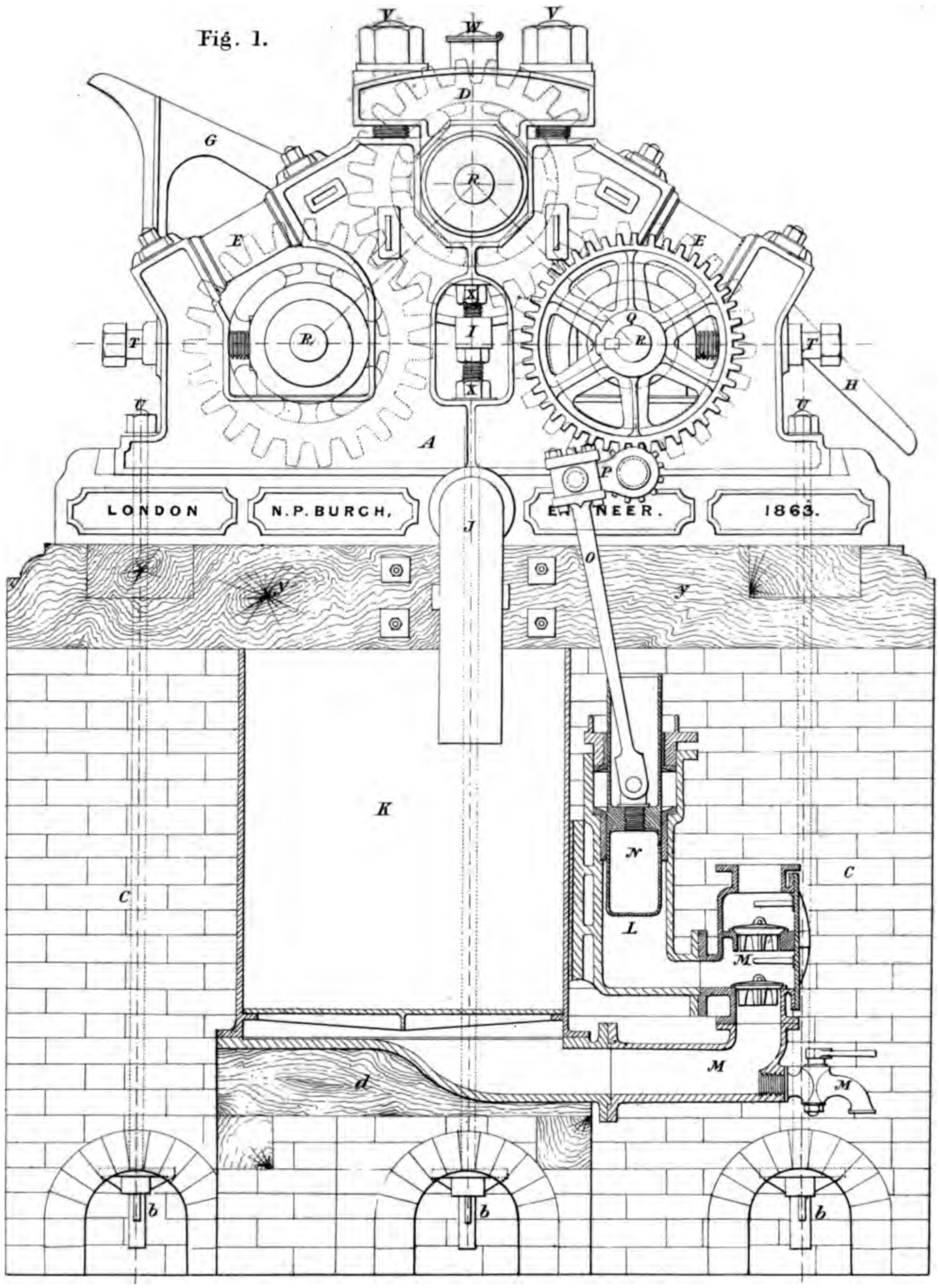
The raw sugar is by the steam crane hoisted into the receiving room and stored in bins, from thence the sugar is let through the shoots into the melting pans in the melting room; when the process is complete, the syrup flows into the bag filters, and from them direct into the charcoal cisterns, the flowing continuing to the receiving tanks. The process is then carried out in the next house, commencing with the vacuum pans, which receives the syrup from the tanks; after the sugar is boiled it is let into the heaters below. Should refined moist sugar be required, it is from the heater (no steam being used) allowed to flow into the centrifugal machine from the trough, after curing put into a square receptacle, and hoisted by the lift to the receiving floor, where it is put into hogsheads or bins. In the case of refined loaf sugar being required, the sugar is from the vacuum pan let into the heater (steam being used), from it into the trough, and thence into the moulds set in long shallow sliding troughs, so that when one set is full it can be shifted to make room for the next, thus dispensing with the primitive mode of filling by hand. After draining into the tank underneath, the moulds are hoisted by the lift into their respective floors, and after draining and cleansing by magney (supplied to each mould by a gutta percha flexible tube in each floor leading from the main pipe, the supply being regulated by a cock on the end of the tube), the sugar is nosed and shaped, and dried in the stove to the required consistency, after which packed in bins on the receiving floor, or the floor beneath. The steam boilers are supplied with water by the donkey engine from the main tank, and coals, which are accessible from the store, access being gained to the stoke hole from the ground floor of the cistern room by an iron ladder. All the apparatus are supplied with power by steam engines separately attached, thus dispensing with the primitive method—viz. a large engine and stupendous gear, shafting, plummer blocks, &c., &c., reducing thereby the expenditure not only at the first outlay, but the contingent expenses which must necessarily follow when heavy machinery is used. The cask steamer is not seen on account of being behind the main water tank; the scum press is also not seen, being behind the bag filters; the nosing, shaping, and crushing machines in a line with each other, worked by a small steam engine on the loaves floor; the set of three throw pumps in like manner in the boiling room used for liquor or syrup. Access to the stove is gained through two doorways in the bastard and lump floors. The stove is of the usual kind; the girders, &c., are made of cast iron, the temperature of the stove being regulated by a damper on the top. All the engines are surrounded by wrought-iron casings, which are removed to show the machinery; the spiral staircases are in the corner of each building, each floor being accessible from them; the refining house has steam pipes surrounding each draining room, so as to maintain the proper temperature. The columns and girders for supporting the floors are of cast iron, the position of each column in plan being equidistant at right angles. The roofs of each building are wrought iron covered with patent tiles. The condensed water boxes are on the outside of the passage on the ground floor, and empty themselves into the drains.

INDEX.

THE END.

C. WHITING, BEAUFORT HOUSE, STRAND.

Fig. 1.



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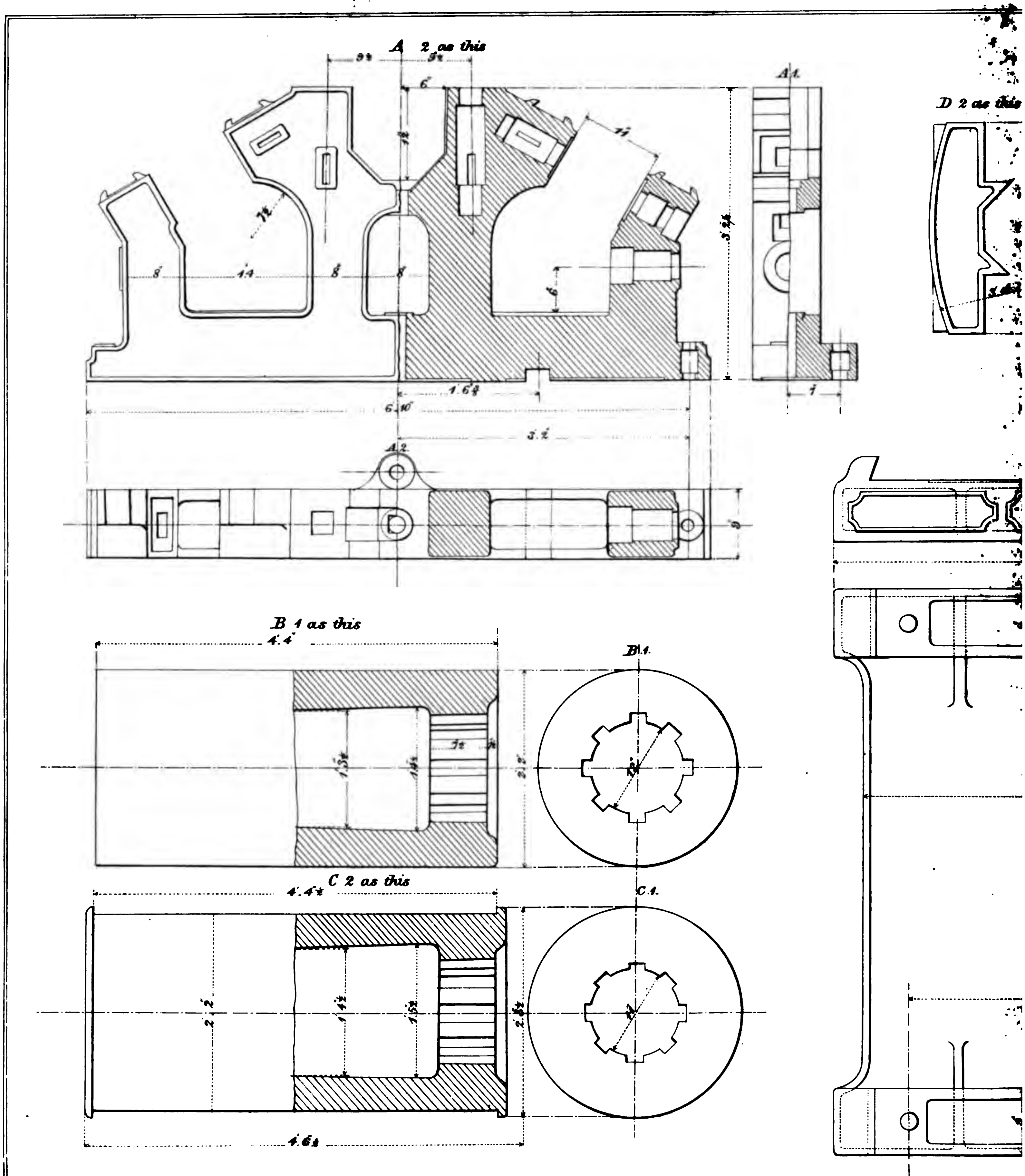

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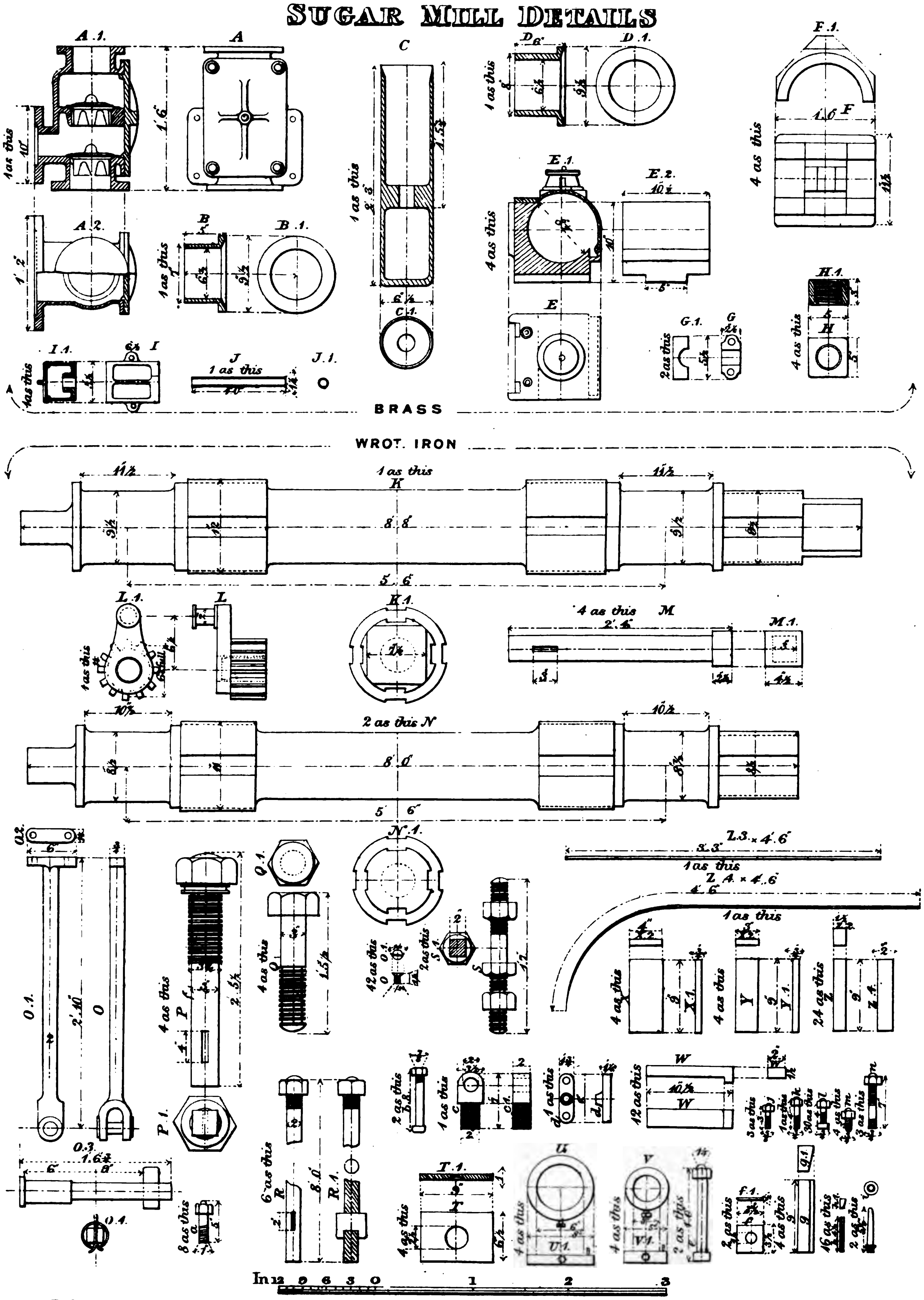
SUGAR MILL DETAILS

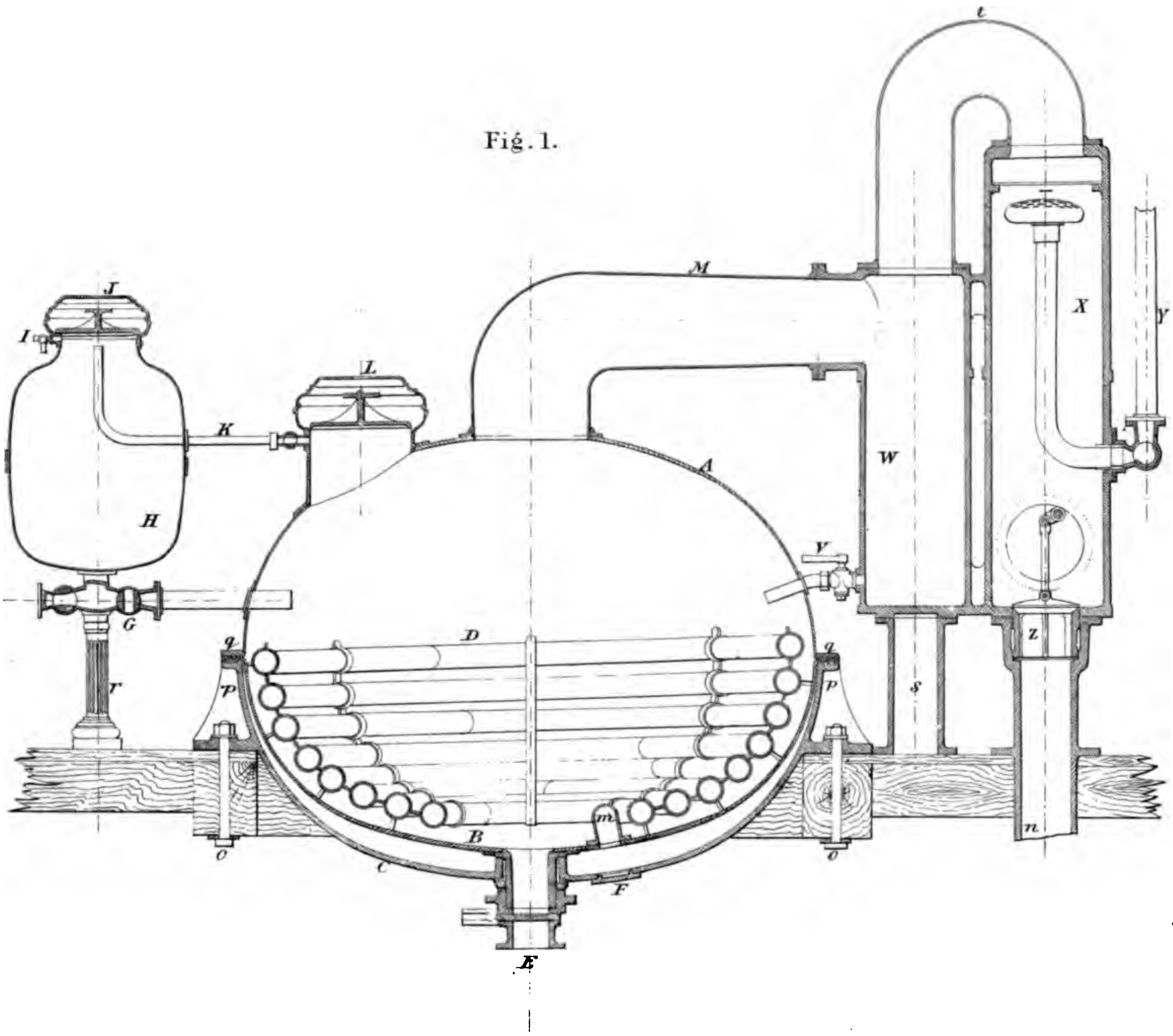


Designed by N. P. Burgh.

R. Newbery

E. & F. N. Spon, 16, Bucklersbury, London.

Fig. 1.



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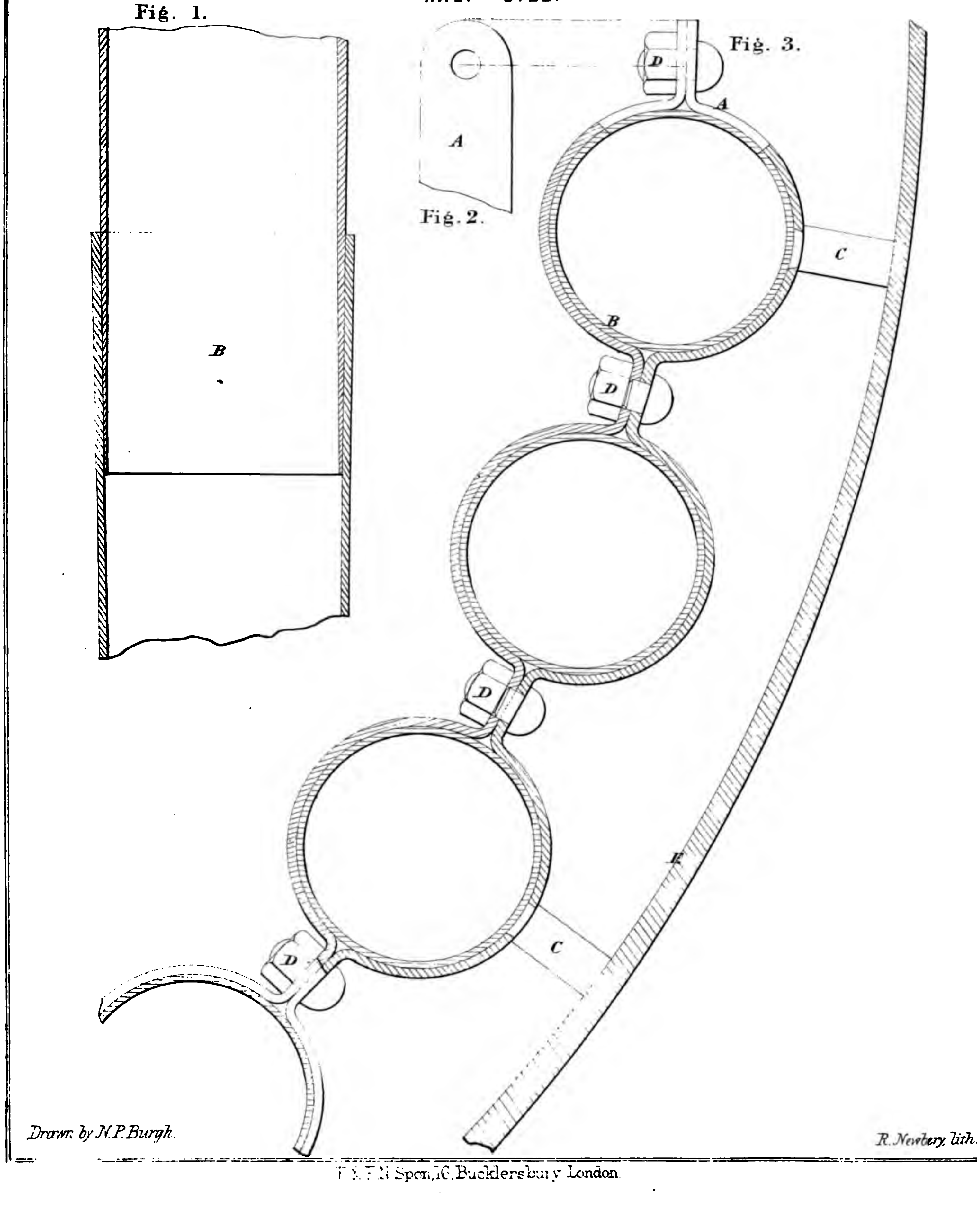
COPPER DETAILS
HALF SIZE.



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R. Newbery lith.

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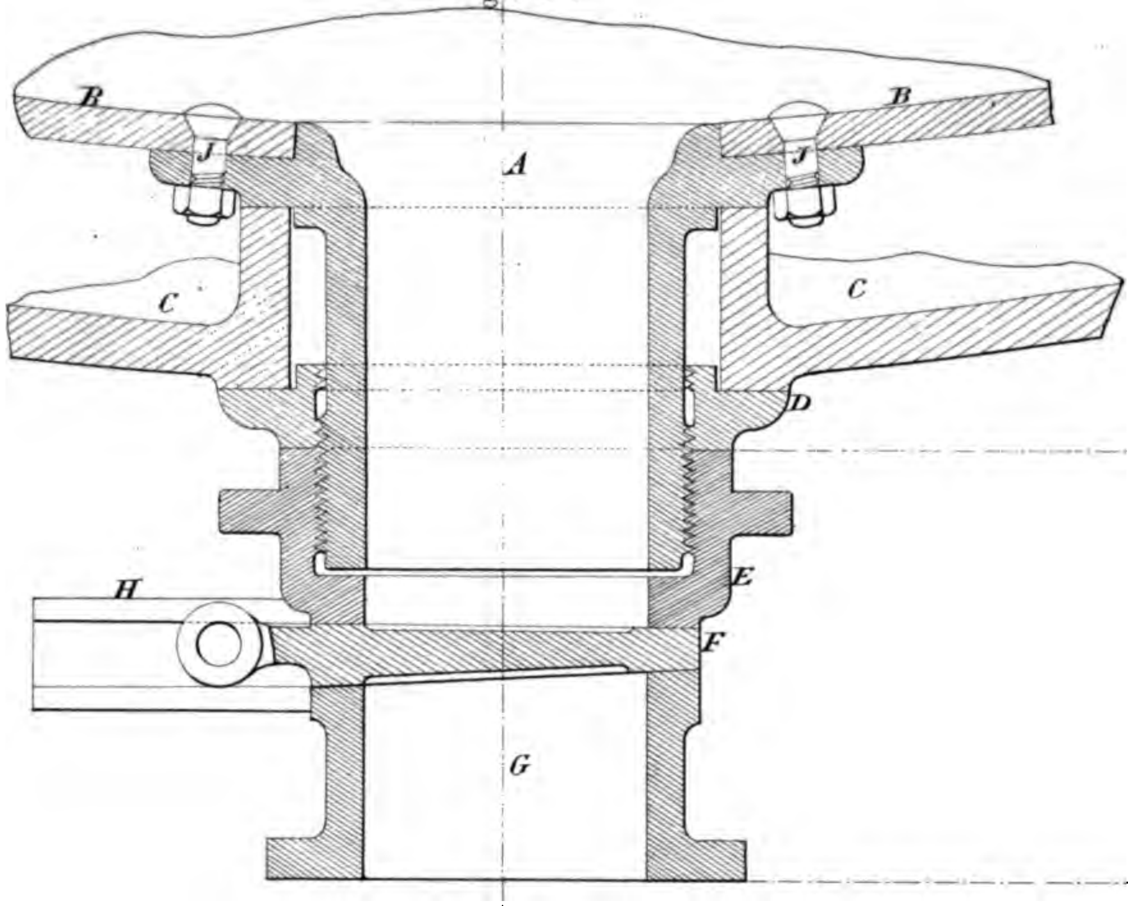
Fig. 1.



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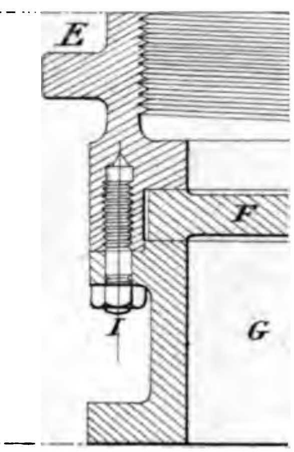

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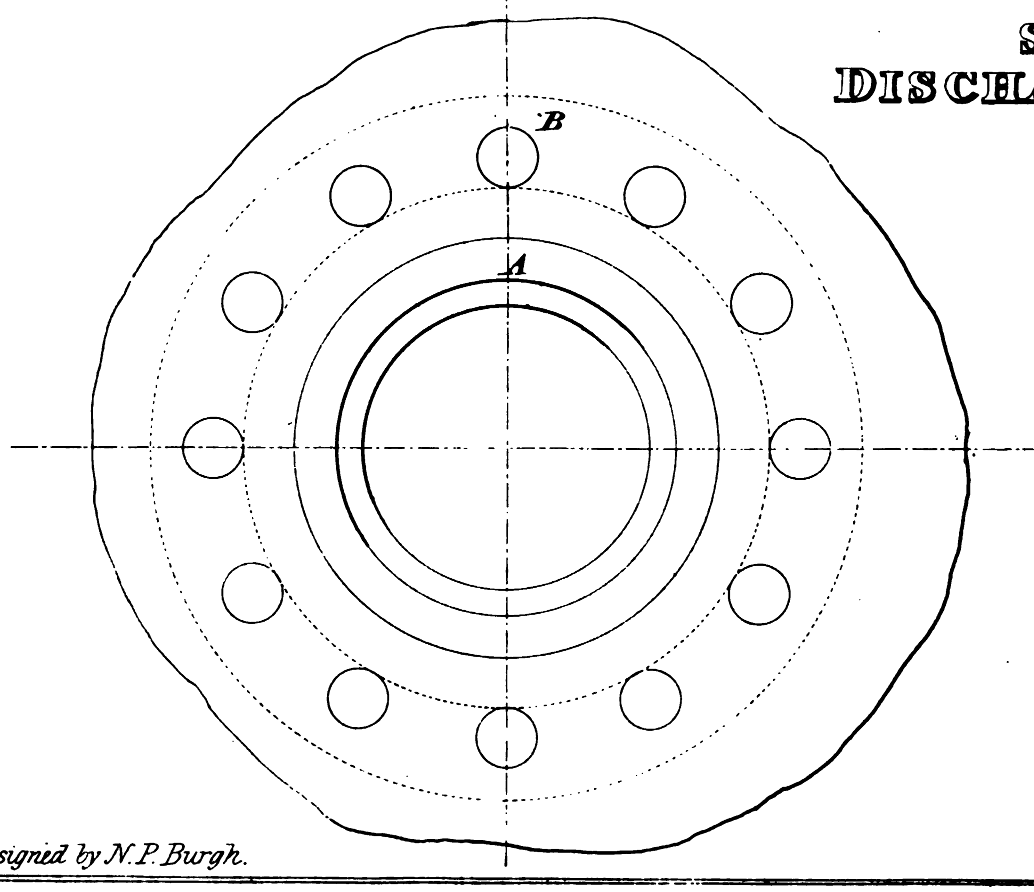
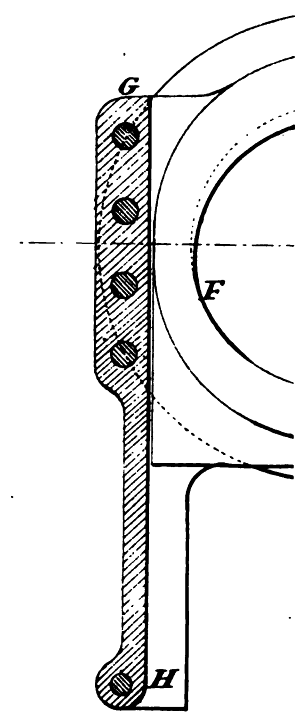


SLUICE DISCHARGE VALVE

Fi



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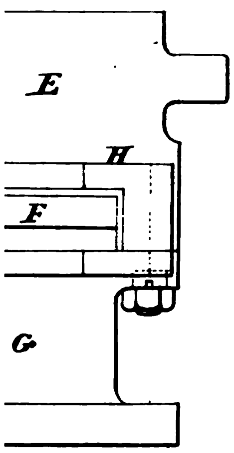
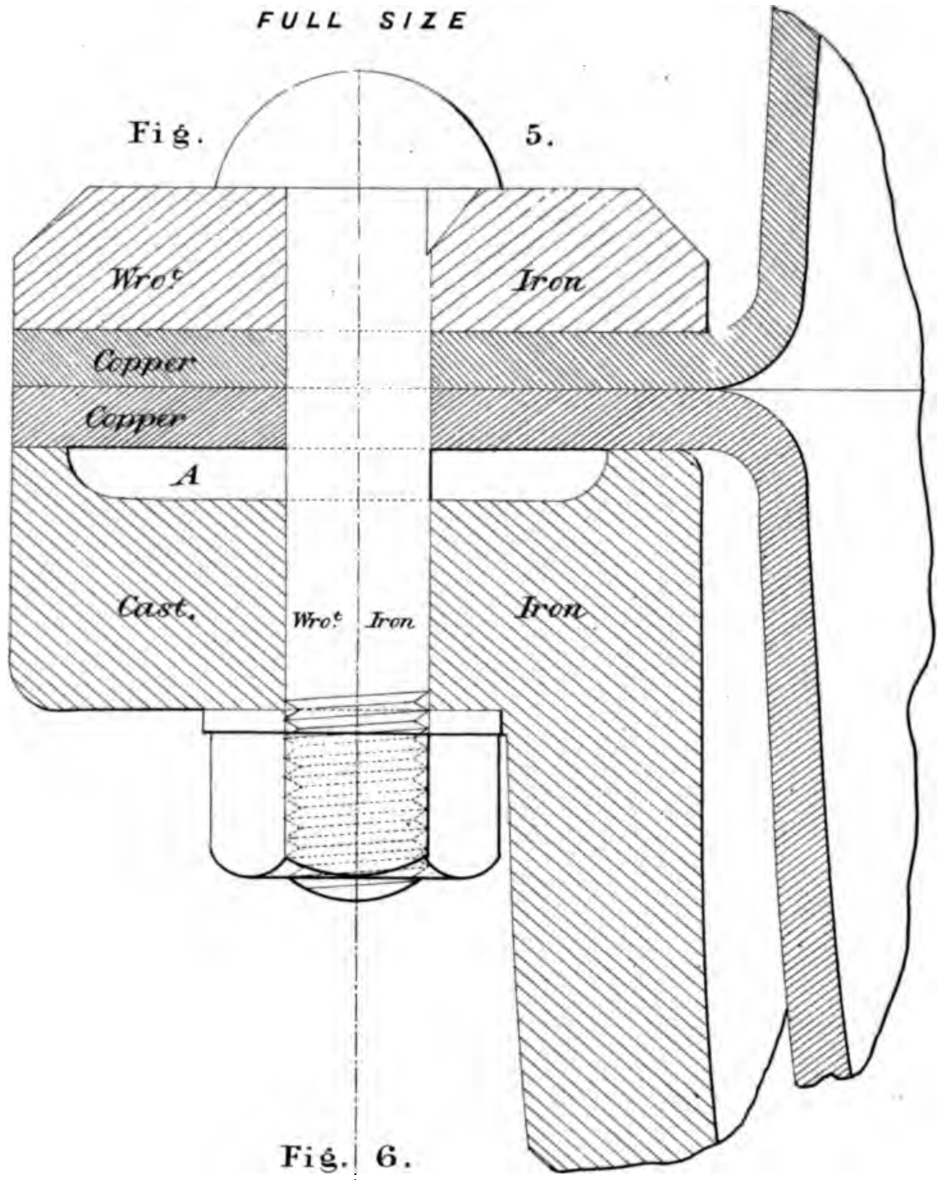
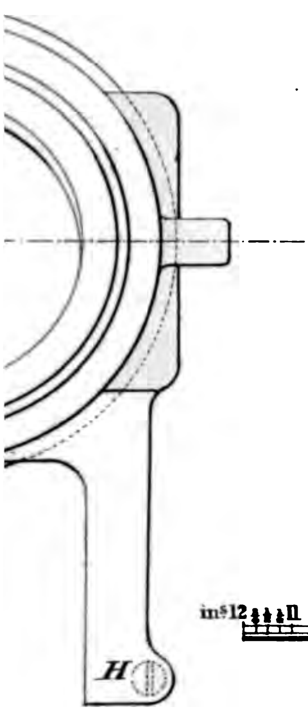


CONNECTION OF FLANGES

FULL SIZE

Fig. 5.





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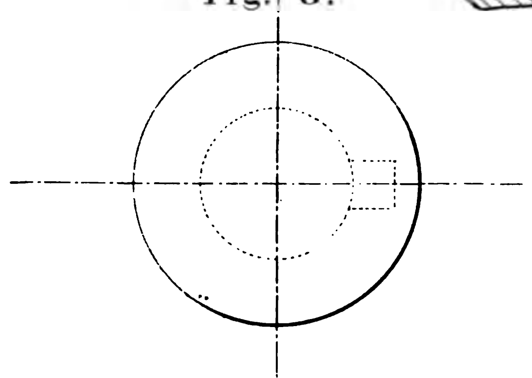

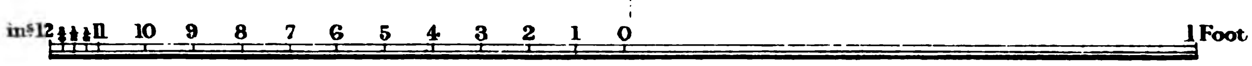

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sbury, London,

Fig. 4.

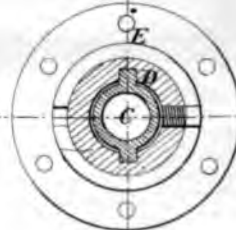

Fig. 5.

D E T

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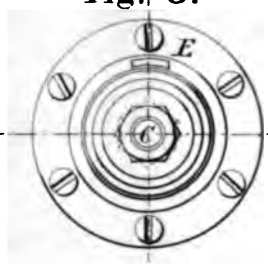
PROOF

Fig. 6.



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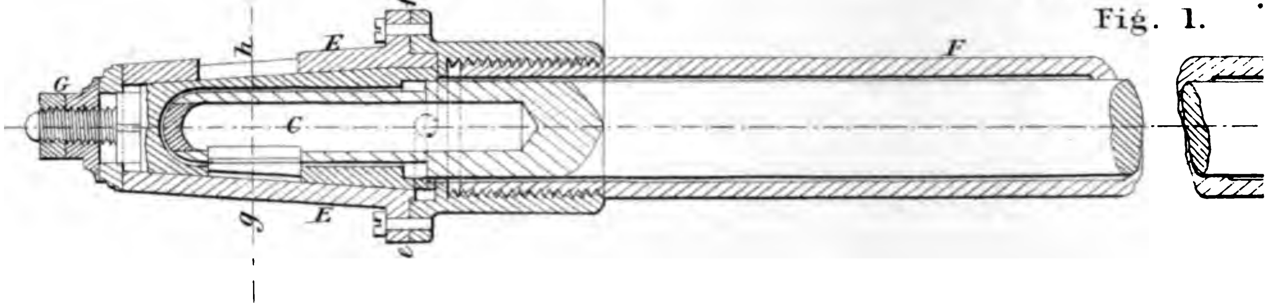
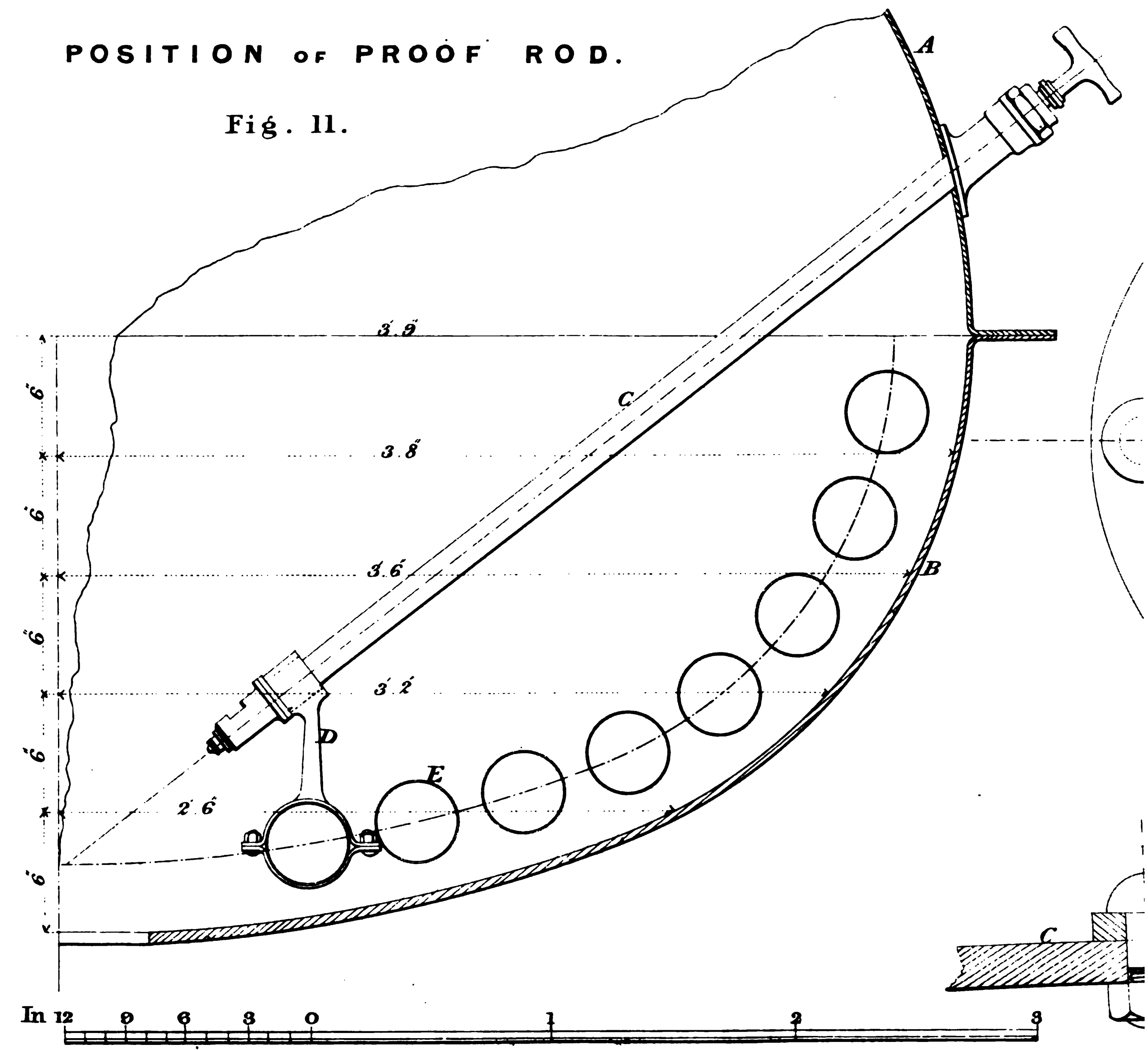


POSITION OF PROOF ROD.

Fig. 11.



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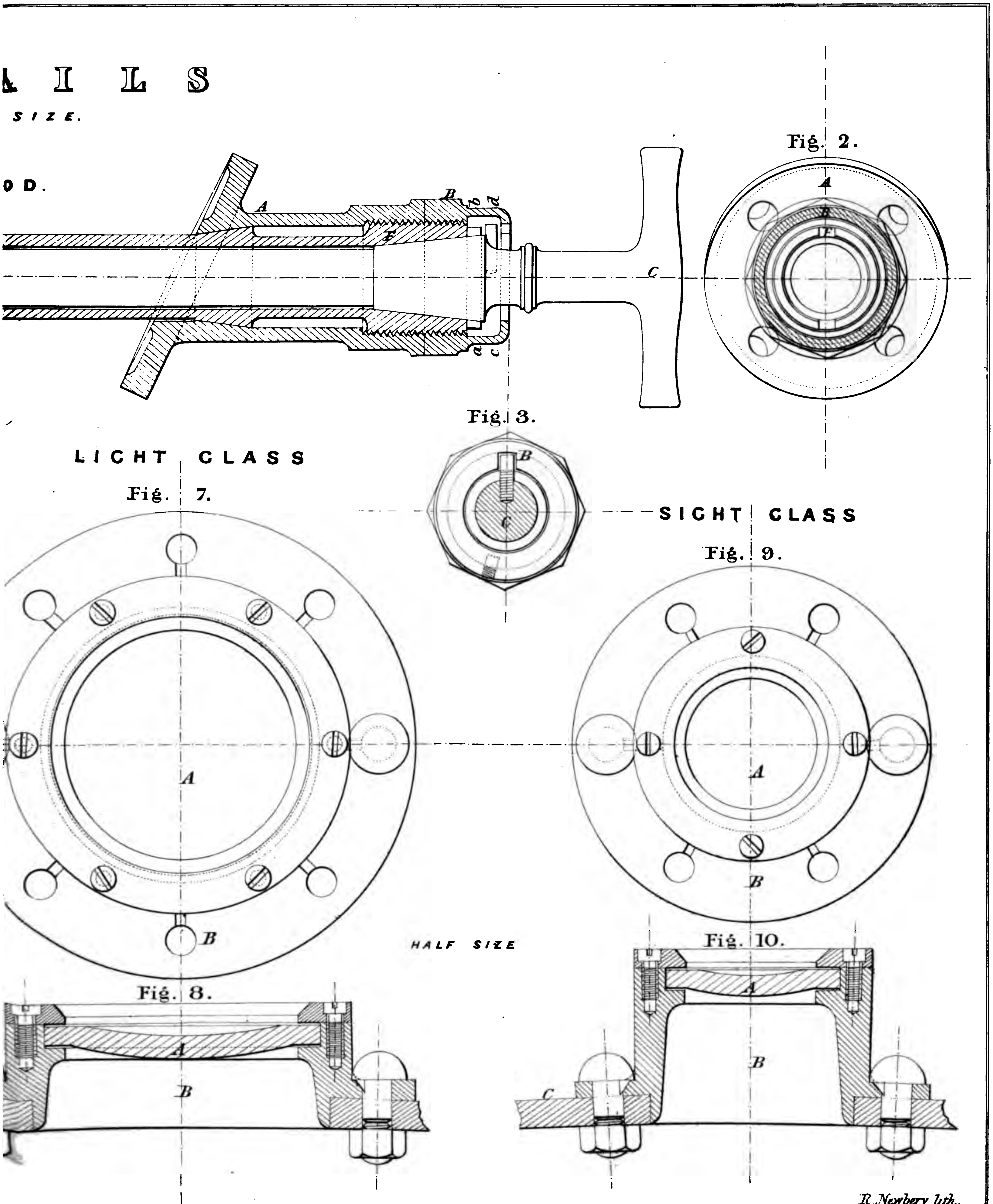

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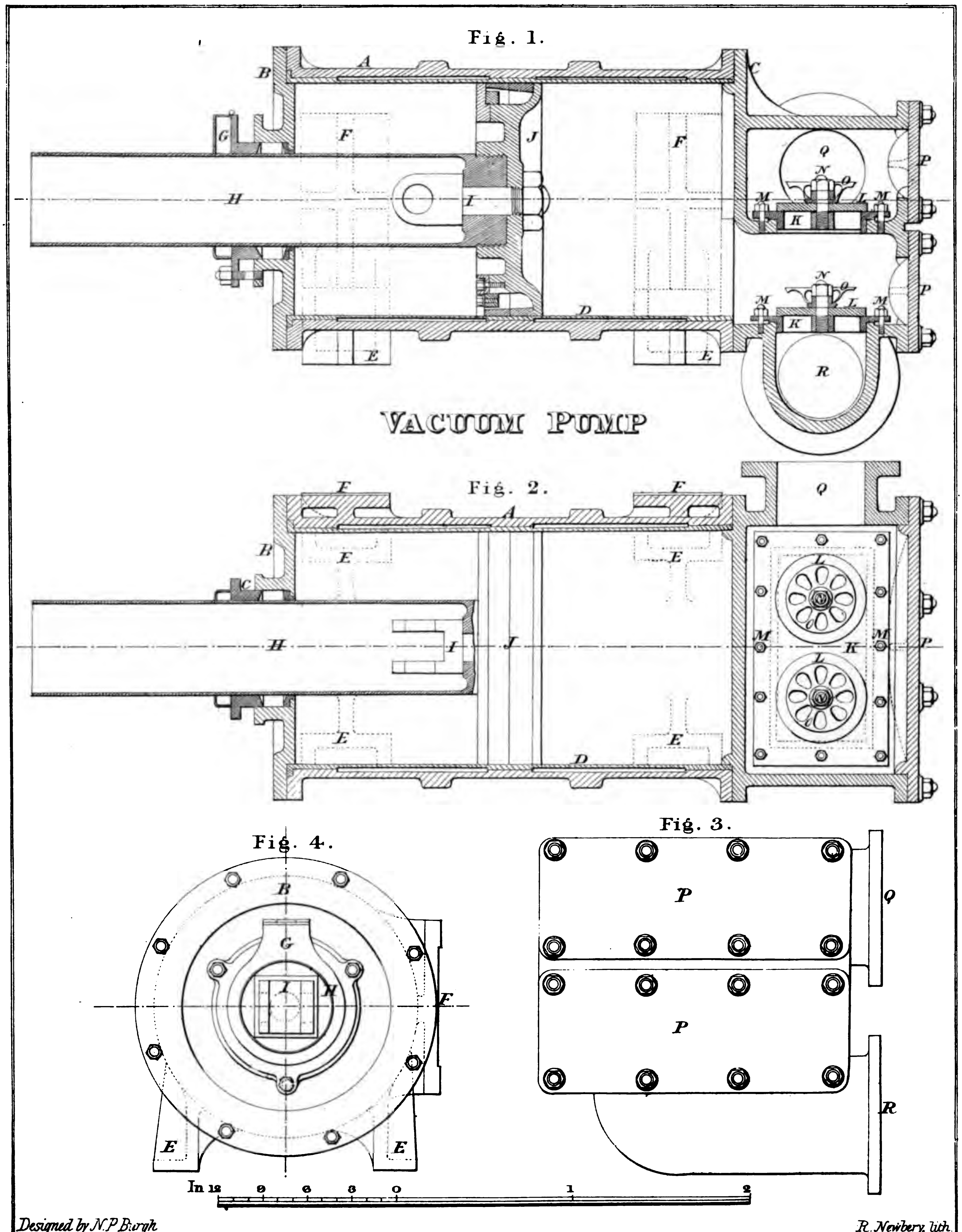

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HEATING PAN.

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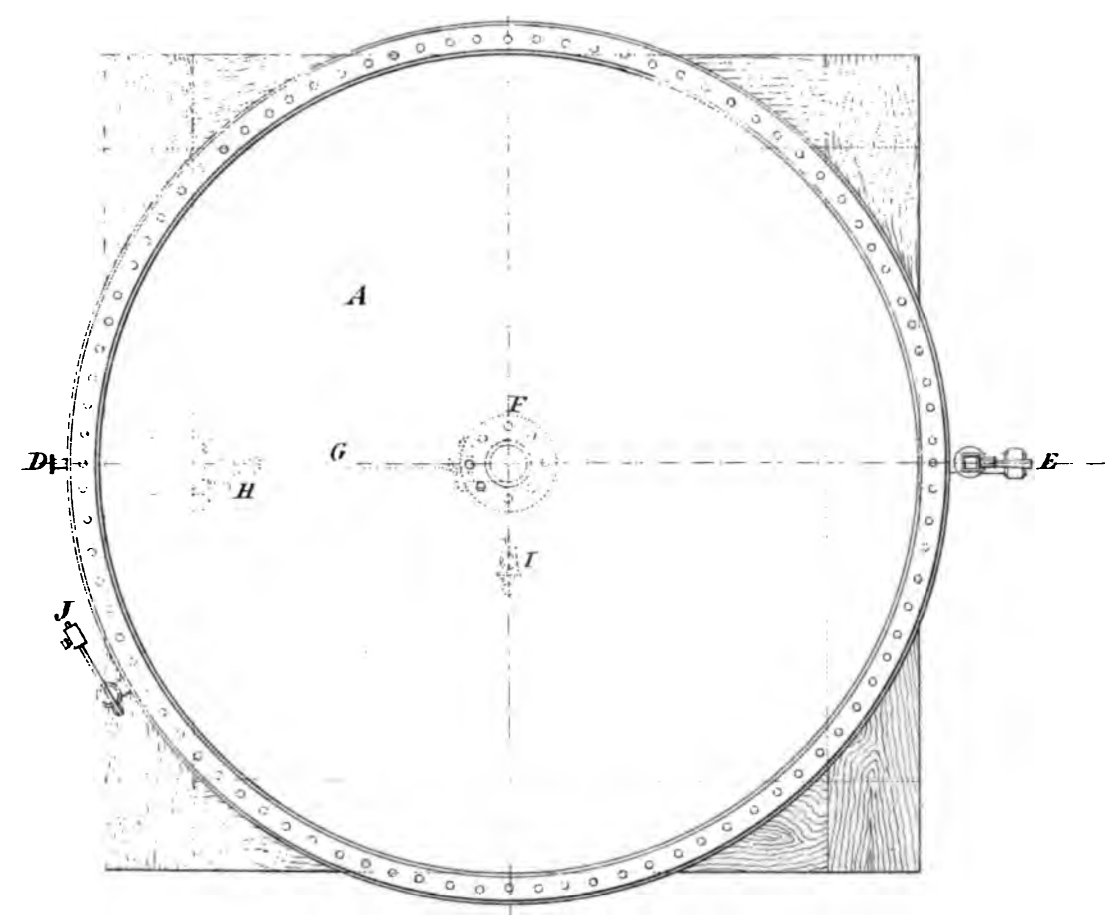
Fig. 1.



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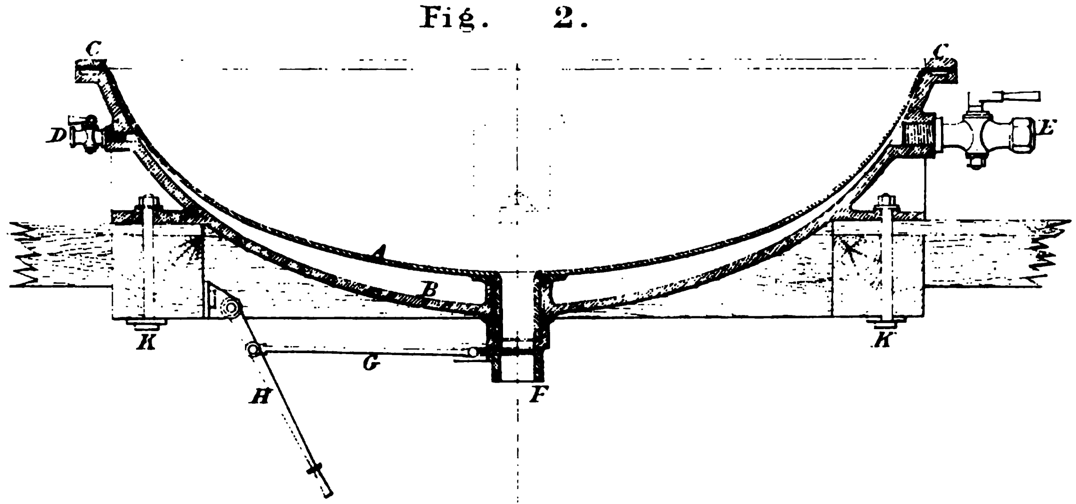

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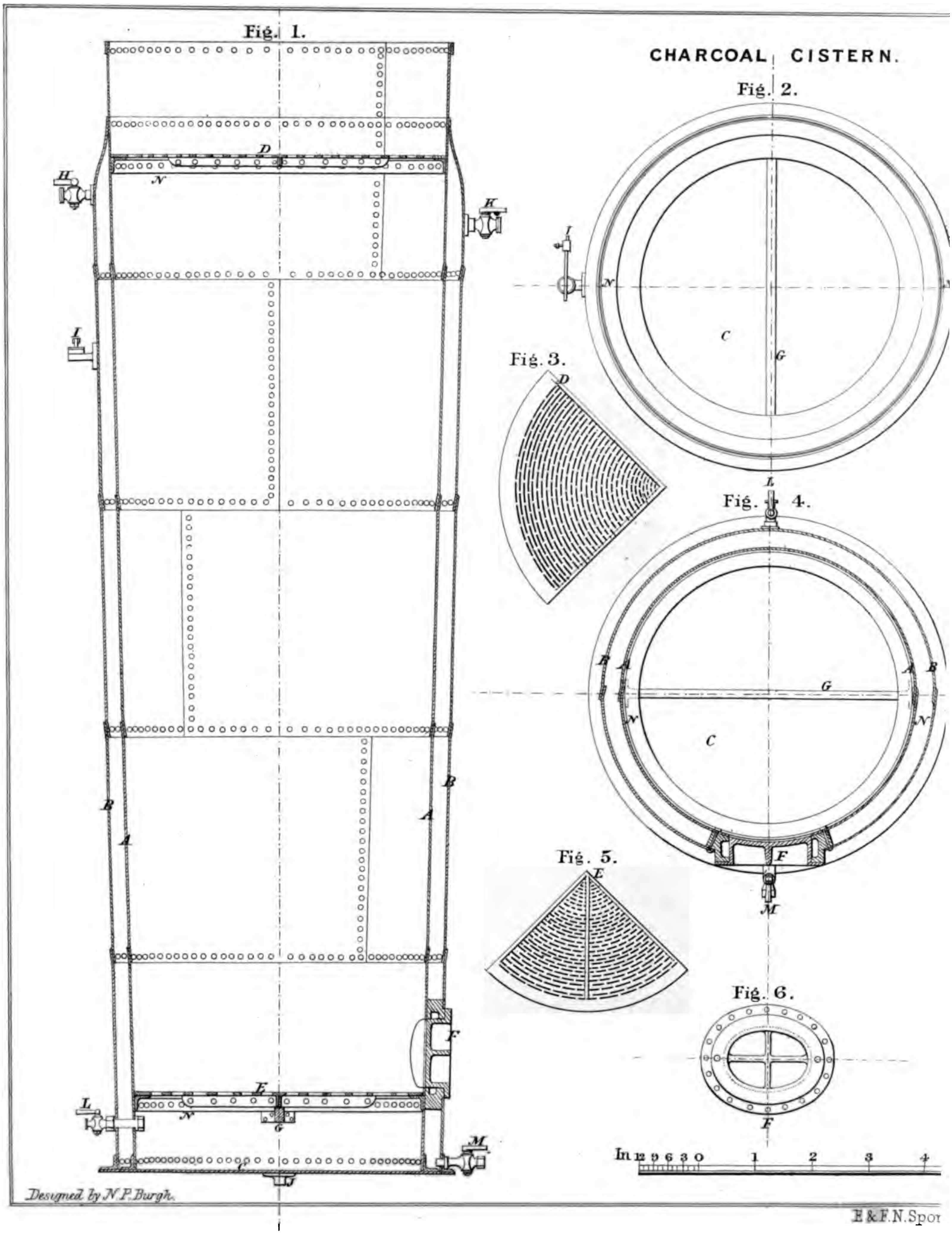
CHARCOAL CISTERN.
Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.
Fig. 5.
Fig. 6.
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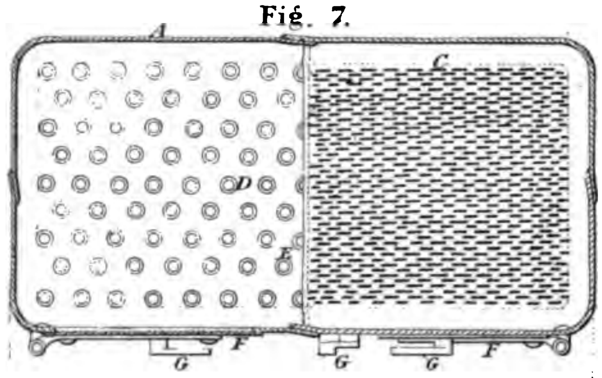
Designed by N. P. Burgh.
E & F. N. Spon

BAG FILTER.

Fig. 7.



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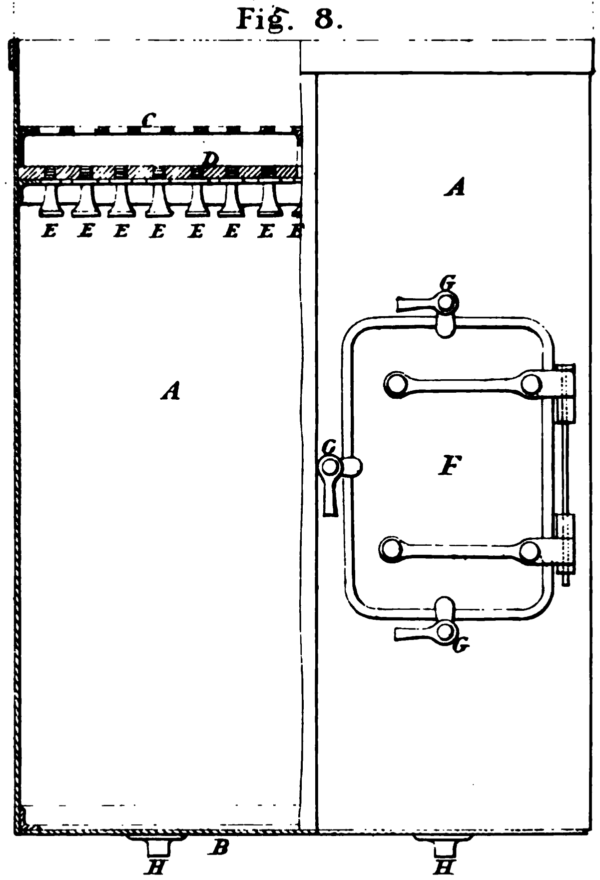


CONDENSING BOX.

Fig. 9.

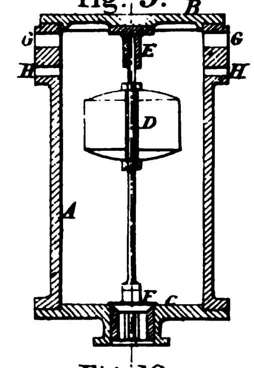
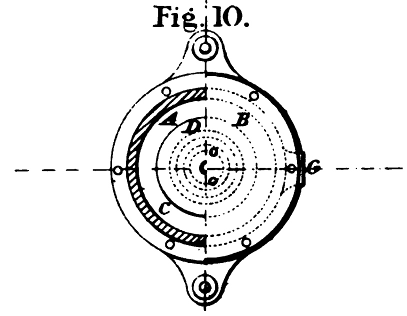
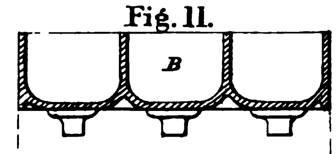


Fig. 10.



DIVISIONAL SIGHT TANK.

Fig. 11.



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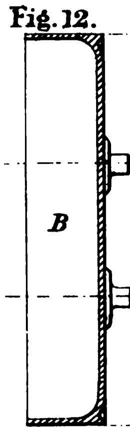

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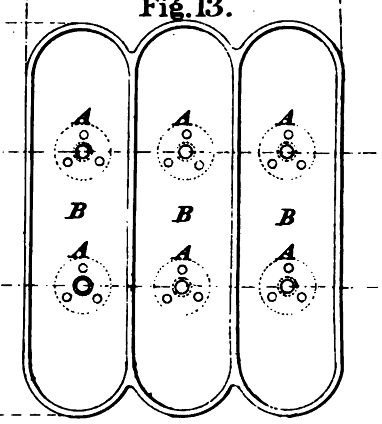

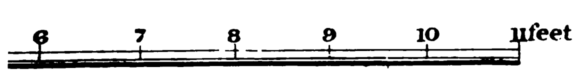

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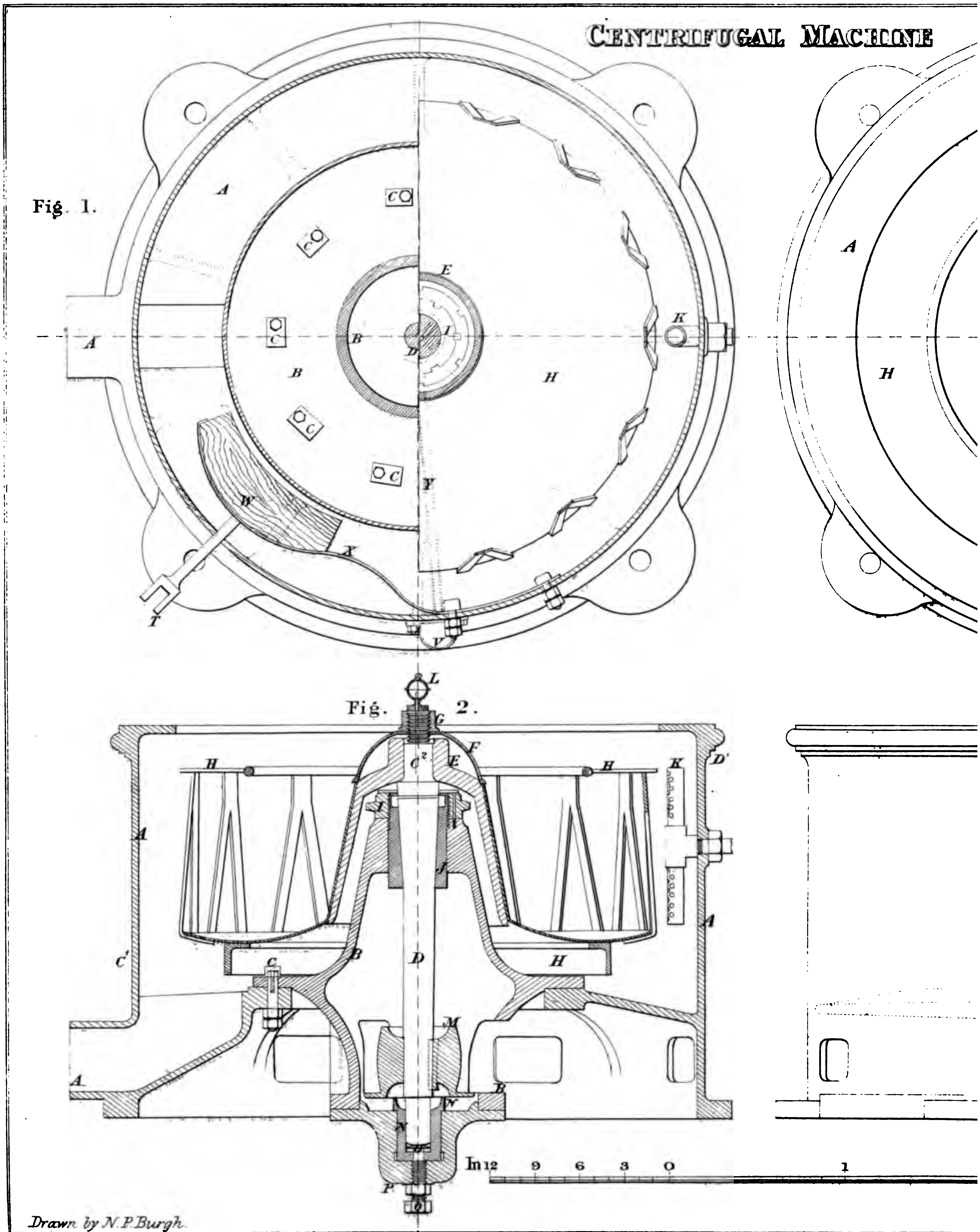
CENTRIFUGAL MACHINE
Fig. 1.
Fig. 2.
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In 12 9 6 3 0 1
Drawn by N. P. Burgh.

E & F.N. Spon

Scum Press

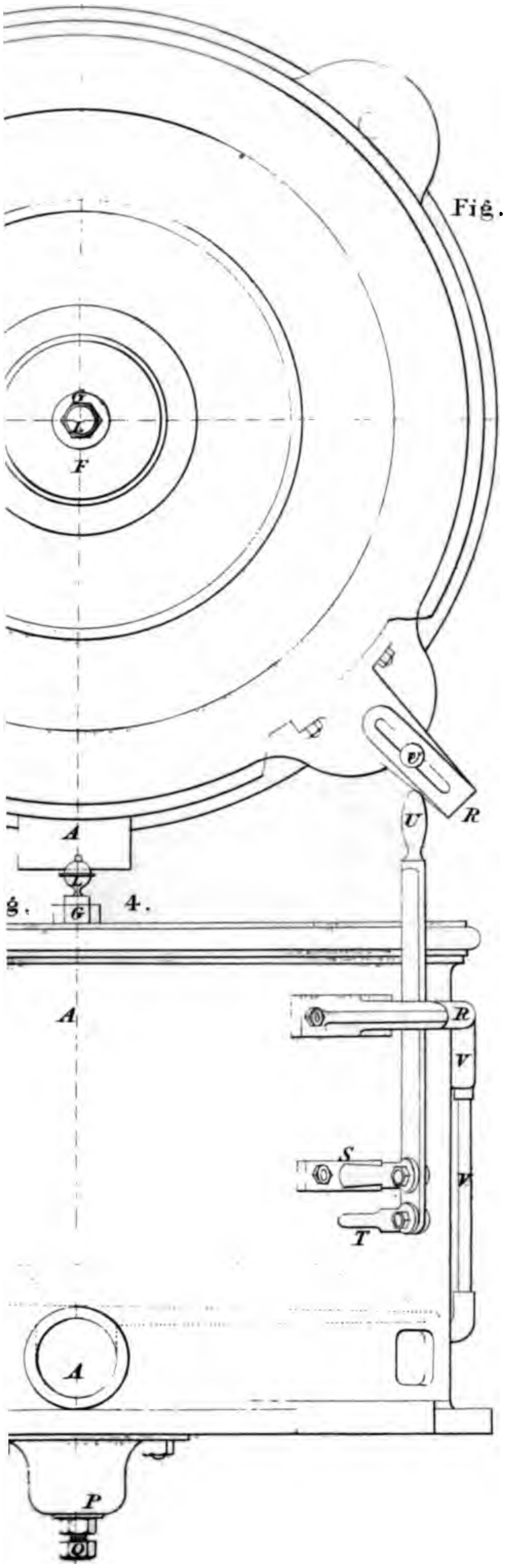
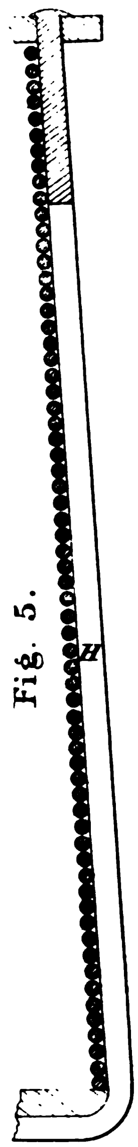


Fig. 3.

ġ. 4.



SECTION OF BASKET HALF SIZE

Fig. 5.

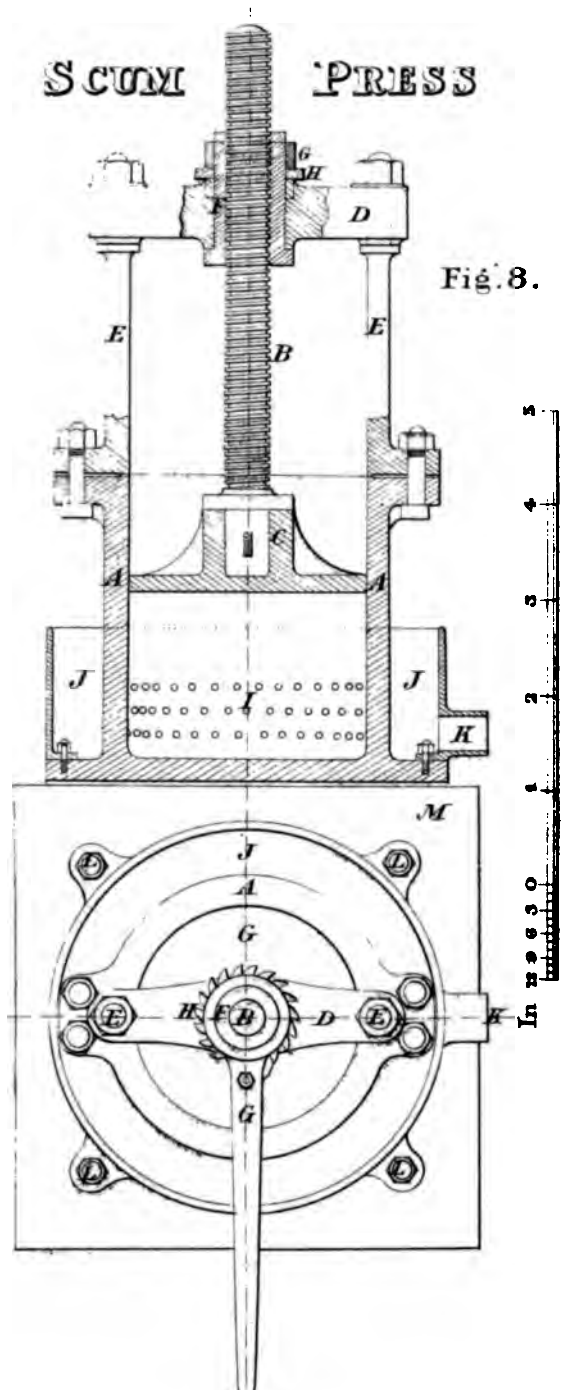


Fig. 8.

PIECE OF STRAINER,

FULL SIZE.

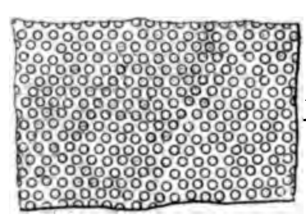
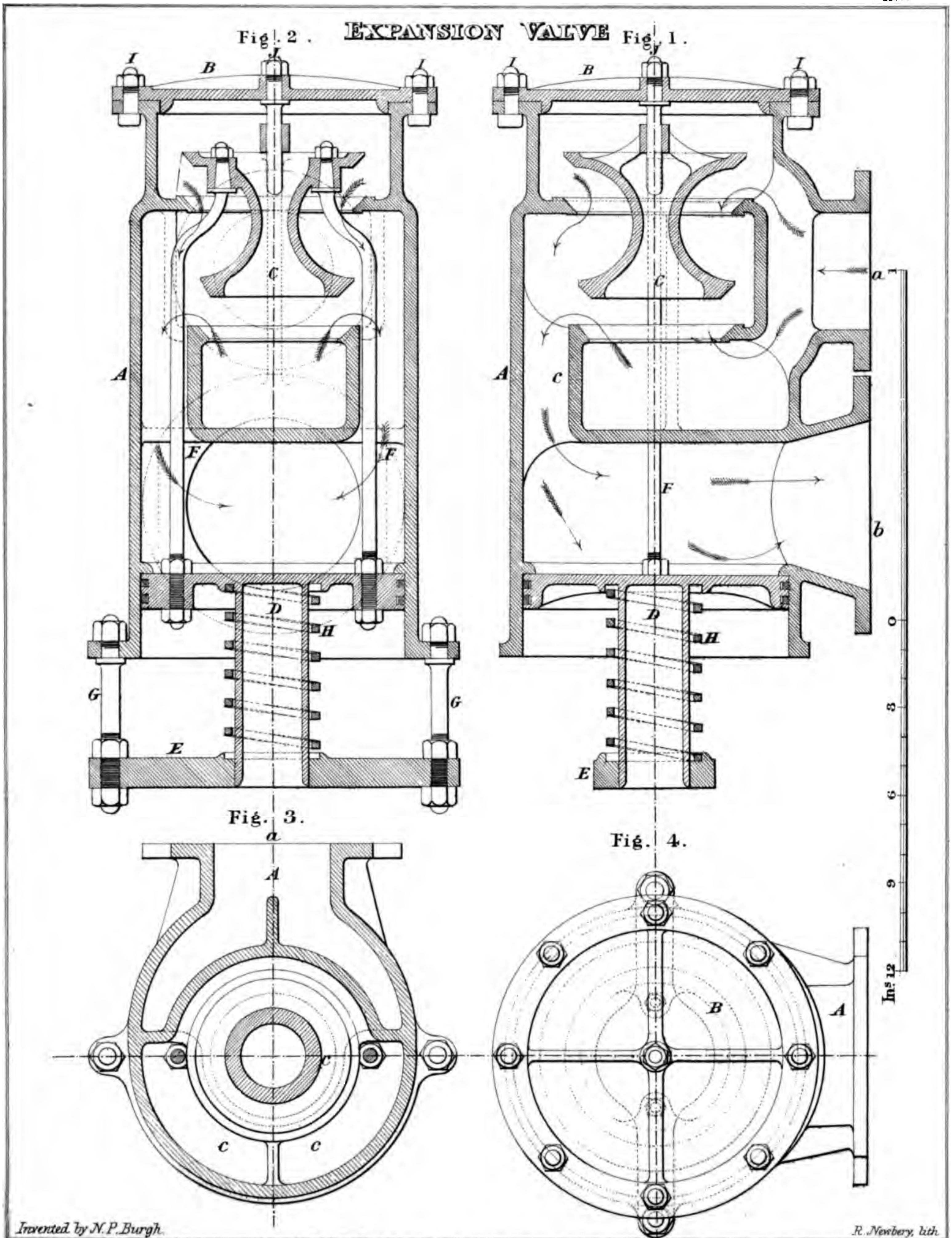


Fig. 6.

Fig. 7.

R. Newbery lith.

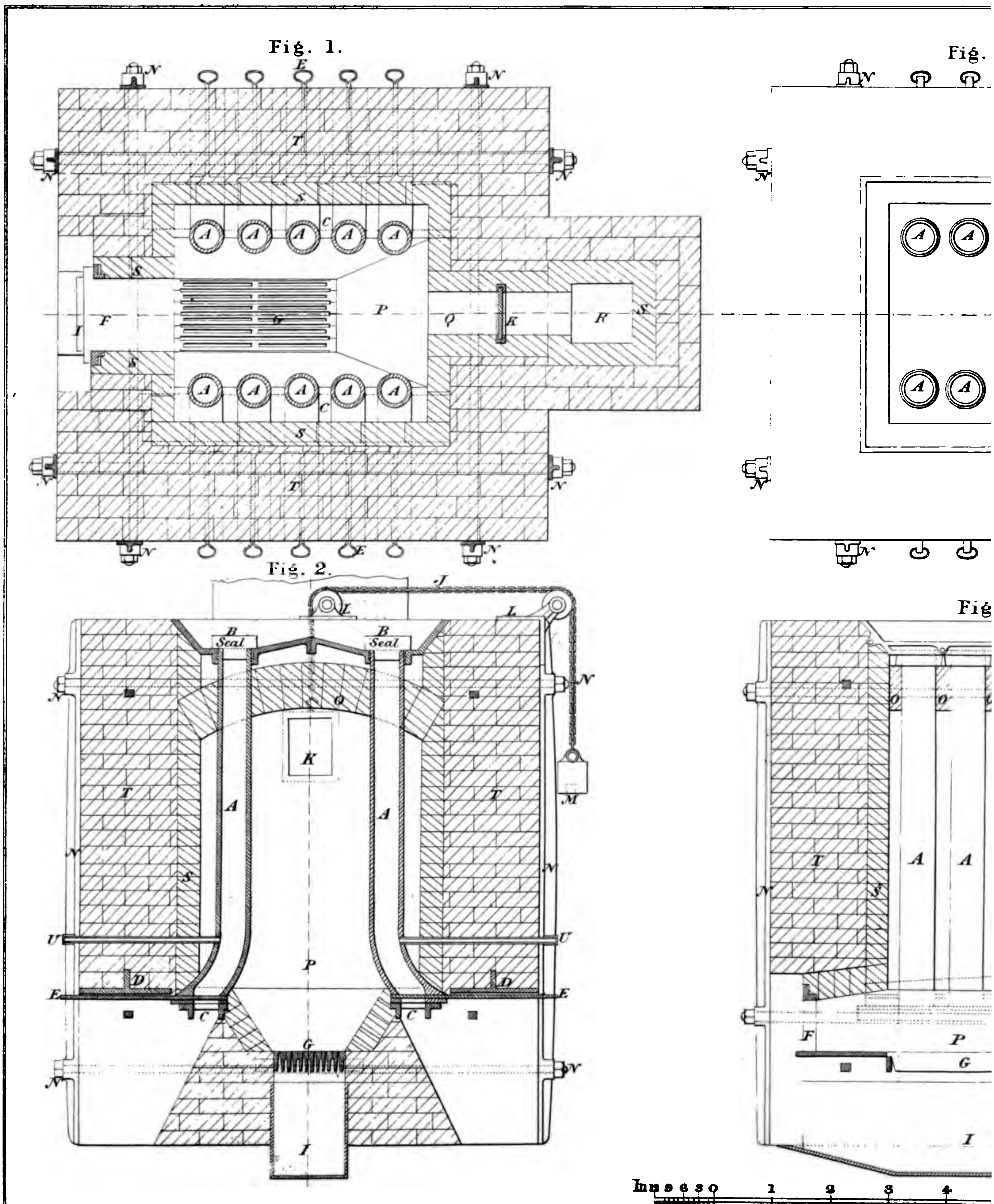
ɪdersbury, London



Invented by N. P. Burgh.

R. Newbery, lith.

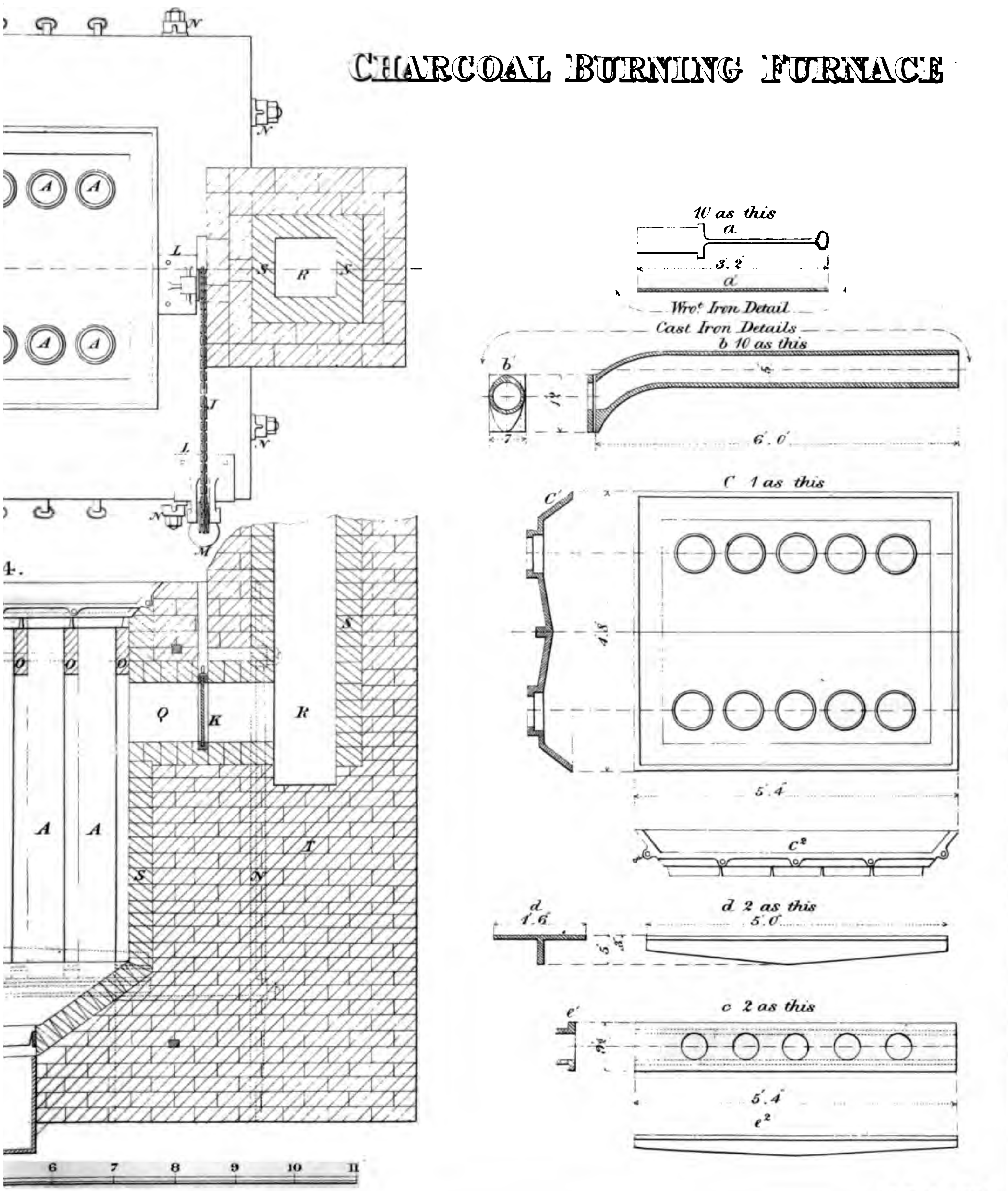
E & F. N. Spon, 16, Bucklersbury, London.



Drawn by N.P.Burgh.

E & F.N.Spon,16

CHARCOAL BURNING FURNACE



R. Newbery, lith.

cklersbury, London

REVOLVING RETORTS

Fig. 1.

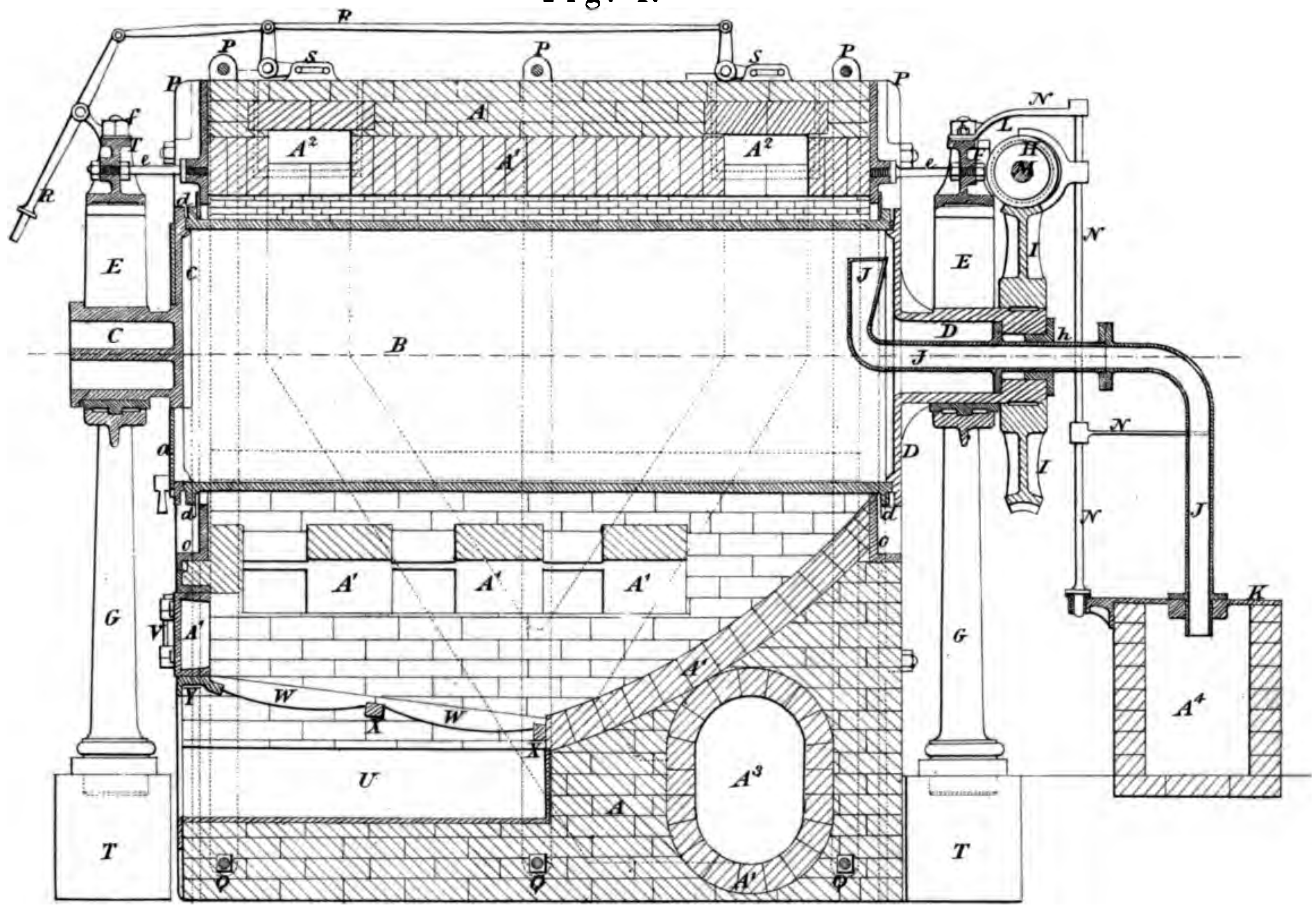


Fig. 2.